VOLUME 62 [W.B. No. 1130] NUMBER 5

# MONTHLY WEATHER REVIEW

## MAY 1934

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## CORRECTIONS

Volume 61, December 1933, page 345, second column, in the equation beginning, "Compare $r_n$ etc.", the denominator of the top fraction should be "$(n-1)r_n$".

Volume 62, February 1934, page 63, table "2" should read "3"; in the last column of this table "cm" should be "mm". Page 64, table "3" should be "2"; page 64, first column, the table headed, "Atmospheric conditions during solar radiation measurements", should be placed on page 63, in the lower part of column 2.

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UNITED STATES OF AMERICA

OCT 9 '34

# MONTHLY WEATHER REVIEW

Editor, W. J. HUMPHREYS

VOL. 62, No. 5
W.B. No. 1130

MAY 1934

CLOSED JULY 3, 1934
ISSUED AUG. 13, 1934

## REDUCTION OF THE BAROMETRIC PRESSURE OVER THE PLATEAU TO THE 5,000-FOOT LEVEL [1]

By DELBERT M. LITTLE and EDWARD M. VERNON

[Weather Bureau, Washington, May 1934]

### INTRODUCTION

In the study of synoptic maps for the western portion of the United States, especially in connection with airways work, meteorologists repeatedly have been confronted with the imperfect state of the barometry of the plateau region. Probably the most conspicuous examples of the imperfection are to be found in certain instances in which various elements such as wind directions and state of weather indicate the presence of a cyclone over the plateau while the existence of the cyclone is not shown by the sea-level isobars. Other instances have been noted in which the sea-level pressure charts showed enclosed lows over the plateau when their existence was not substantiated either by wind circulation or by other meteorological elements. Indeed, the inaccuracies in the configurations shown by the sea-level pressure charts for the plateau region, particularly for that portion lying to the west of the Continental Divide, tend to lead those who believe in them to the conclusion that the usual concepts of the relationship of various meteorological elements to pressure configurations apply only to a very limited degree over the plateau. However, it is rather to be expected that the dynamic processes involved in producing various types of weather over the plateau are substantially the same as those involved elsewhere. This study has been undertaken in the hope of being able to support the belief that the sea-level pressure map could be advantageously supplemented by a pressure map based on pressures adjusted to a level approximately that of the surface of the plateau.

The thought of reducing pressures to a height other than sea level is not at all new. The first progressive steps along this line were probably taken by Professor Bigelow (1) who constructed tables for reducing pressures to the 3,500-foot level and to the 10,000-foot level. Later, Meisinger (2) developed an ingenious method for reducing surface pressures for the eastern two-thirds of the United States up to the 1- and 2-kilometer levels. The project which has been here undertaken differs from Bigelow's chiefly in that reductions through great depths are not attempted, while it covers a section of the United States not embraced in Meisinger's study.

In order to make possible the preparation of pressure maps for the "surface" of the plateau, only those stations lying reasonably near to the 5,000-foot level, some above and some below, have been selected. No attempt was made to reduce pressures for stations lying at or near the sea-level plane up to 5,000 feet. In this way the possible magnitude of errors due to erroneous assumptions as to the mean temperature of the reduction column is reduced to a minimum.

In attacking this problem a modified form of the hypsometric equation was used to construct tables by means of which the reduction of pressure to the 5,000-foot level could be readily performed. Considerable care was exercised in the construction of the tables and, in order that all errors apparent in the reduced pressures might be attributable to one and only one source (erroneous assumption as to mean temperature), allowance was made for all influences which could have an appreciable effect on the pressure reductions. With these precautions, one may feel secure in stating that the reduced pressures will be accurate so far as the mean temperature used in making the reduction is accurate, and that the possible errors due to the use of incorrect mean temperature arguments will be small as compared to similar errors in sea-level pressure reductions.

The advisability of applying a correction for the so-called plateau effect, particularly the correction $C \cdot \Delta\theta \cdot H$ used by Ferrel (3) and Bigelow (1) was considered. It was concluded that a plateau correction was of minor importance for the relatively short reduction columns applying from station level to the 5,000-foot level, and that if the correct temperature argument were used in obtaining the mean temperature of the air column no other temperature correction would be necessar or proper. It would appear rather that the plateau correction becomes applicable when one reduces pressures to sea level from an extensive plateau region and wishes to compare such reduced pressures with those obtained from neighboring low-lying regions. Here too, the arbitrary nature of the assumed mean temperature of the "air column" for the plateau region must come into consideration. This aspect of the situation still remains to some extent in the present attack on the problem at hand and requires a rational solution not yet perfectly attained. However, in the present instance the errors from this source are not nearly as great in general as those to be expected in the case of reductions of pressure to sea level.

In view of the above, it is expected that the synoptic pressure maps for the 5,000-foot level may be a valuable

[1] For the convenience of some who may not have had much experience in the use of the hypsometric equation, the mathematical formulae involved are given in full detail.

supplement to the maps for sea level which have been thus far used.

### METHOD USED IN COMPUTING BAROMETER REDUCTION TABLES FOR THE 5,000-FOOT LEVEL

The hypsometric equation as given in the Smithsonian Meteorological Tables, 1931 edition, is:

$$(1)\quad Z=K(1+\alpha\theta)\left(\frac{1}{1-0.378\frac{e}{b}}\right)\left(1+\frac{g_o-g_l}{g_o}\right)\left(1+\frac{h+h_o}{R}\right)\left(\log\frac{p_o}{p}\right)$$

in which

$h$ = height of the upper station.
$h_o$ = height of the lower station.
$Z=h-h_o$.
$p$ = atmospheric pressure at the upper station.
$p_o$ = atmospheric pressure at the lower station.
$R$ = Mean radius of the earth = 20,890,127 feet.
$\theta$ = Mean temperature of the air column between the altitudes $h$ and $h_o$.
$e$ = mean pressure of aqueous vapor in the air column.
$b$ = mean barometric pressure of the air column.
$K$ = barometric constant = 18,400 meters or 60368 feet.
$\alpha$ = coefficient of the expansion of air = 0.00367 for 1° C.
$g_o$ = standard value of gravity = 980.665 dynes.
$g_l$ = local value of gravity.

Transposing and simplifying with justifiable approximations in the right-hand portion of the equation similar to equation on page xlii Smithsonian Meteorological Tables, 1931 edition:

$$(2)\quad K(1+\alpha\theta)\log\frac{p_o}{p}=Z-Z\left[0.378\frac{e}{b}+\frac{g_o-g_l}{g_o}+\frac{Z+2h_o}{R}\right]$$

In English Units:

$$(3)\quad 60368[1+0.002039(\theta-32)]\log\frac{p_o}{p}=Z-Z\left[0.378\frac{e}{b}+\frac{g_o-g_l}{g_o}+\frac{Z+2h_o}{R}\right]$$

In the above equation (3) let $K'$ represent the term $60368[1+0.002039(\theta-32)]$. Then obviously $K'$ is identical to $K=60368$ when $\theta=32°$ F. Values of $K'$ for other temperatures, and their logarithms used in the construction of the reduction tables are as follows:

| θ °F. | Values of K' | log 10 K' | θ °F. | Values of K' | log 10 K' |
|---|---|---|---|---|---|
| −20 | 53967.3 | 4.73213 | 50 | 62583.6 | 4.79646 |
| −10 | 55198.2 | 4.74192 | 60 | 63814.5 | 4.80492 |
| 0 | 56429.1 | 4.75150 | 70 | 65045.4 | 4.81322 |
| 10 | 57660.0 | 4.76087 | 80 | 66276.3 | 4.82136 |
| 20 | 58890.9 | 4.77005 | 90 | 67507.2 | 4.82935 |
| 30 | 60121.8 | 4.77903 | 100 | 68738.1 | 4.83720 |
| 40 | 61352.7 | 4.78783 | | | |

By combining the temperature term $[1+0.002039(\theta-32)]$ with $K$ instead of applying a portion of it as a correction to $Z$, the computation of reduction tables is somewhat simplified as well as more exact.

The gravity term $\left(\frac{g_o-g_l}{g_o}\right)$ was handled as follows: For stations below the 5,000-foot level, where corrections for gravity anomaly, topography and compensation are known, i.e., Mount Hamilton, Winnemucca, Salt Lake, Lander, Grand Junction, Sheridan, and El Paso, the value of $g_l$ (local gravity) was computed.

#### EXAMPLE A

Mount Hamilton, elevation 4,212.6 feet, latitude 37°20.4′, longitude 121°38.6′:

| | Dynes |
|---|---|
| Mean gravity at sea-level, corresponding to latitude 37°20.4′, table 90, Smithsonian Meteorological Tables, fifth edition | 979.937 |
| Correction for height $-0.000094\times4212.6$ | −.396 |
| Correction for gravity anomaly (U.S.C.G.S. special publication no. 40, by Wm. Bowie) | −.003 |
| Correction for topography and compensation special publication no. 40, by Wm. Bowie | +.120 |
| Local gravity | 979.658 |

$$\left(\frac{g_o-g_l}{g_o}\right)=\frac{980.665-979.658}{980.665}=0.00102$$

$$Z\left(\frac{g_o-g_l}{g_o}\right)=787.4\times0.00102 \quad = .803 \text{ ft.}$$

In all cases where the value of local gravity was thus known, the value of $h_o$ in the gravity correction term for altitude $Z\left(\frac{Z+2h_o}{R}\right)$ was employed as *zero*, because the correction for height of the lower station is taken care of in the computation of local gravity and correction to standard gravity (see above computations). Substituting values for Mount Hamilton:

#### EXAMPLE B

$$Z\left(\frac{Z+2h_o}{R}\right),\ 787.4\left(\frac{787.4+0}{20,890,127}\right)=0.03 \text{ ft.}$$

For stations above the 5,000-foot level where corrections for gravity anomaly, topography, and compensation are known, i.e., Rock Springs, Denver, and Tonopah, the value of local gravity at the station elevation was computed as in example A. The reduction of the local station gravity to gravity at the 5,000-foot level was accomplished as follows:

#### EXAMPLE C

Rock Springs, Wyo., elevation 6,374.42 feet.
Value of local station gravity, 979.727 dynes.

$g_l$ at 5,000-foot level $=979.727\left(1+\frac{2Z}{R}\right)$. That is, $979.727\left(1+\frac{2748.84}{20,890,127}\right)=979.857$ dynes, the value of $g_l$ at the 5,000-foot level. This last gravity value makes the expression $Z\left(\frac{g_o-g_l}{g_o}\right)=1.132$ feet. In this case also the value of $h_o$ was employed as *zero* in the expression $Z\left(\frac{Z+2h_o}{R}\right)$.

For all other stations, the value of local gravity was unknown and the correction was computed as follows:

#### EXAMPLE D

Helena, Mont., elevation 4,123.7 feet, latitude 46°34′.

$Z\left(\frac{g_o-g_l}{g_o}\right)$ was taken as equal to $Z(0.00264\cos2\phi-0.000007\cos^2 2\phi+0.000045)$

Substituting latitude for $\phi$ and solving gives $Z(-0.00008958294463)=-0.043$ foot.

$g_l$ here represents local gravity at sea level.

In all such cases where the value of local gravity was unknown and the computed correction was for gravity at *sea level* at the latitude of the station, the altitude

($h_o$) in the second gravity correction term $\left[Z\left(\frac{Z+2h_o}{R}\right)\right]$ was taken as the height of the lower level above sea level, whether it was the adopted "station elevation" or 5,000 feet, the level to which reductions of barometric pressure were made.

The correction for water vapor $\left[Z\left(0.378\frac{e}{b}\right)\right]$ contains a ratio of the mean pressure of water vapor in the air column to the mean barometric pressure of the air column and cannot be obtained directly by surface observations. Combining Hann's (**4**) equation for the decrease of vapor pressure with height in mountainous regions $[e=e_o\ (10^{-\frac{Z}{20670}})]$ with $[B=B_o\ (10^{-\frac{Z}{60368}})]$, the approximate hypsometric relationship, the following equation is arrived at—

$$(4)\qquad \left(\frac{e}{B}\right)=\left(\frac{e}{B}\right)_o 10^{-0.0000317Z}, \text{ approximately.}$$

$\left(\frac{e}{B}\right)$ represents the ratio of vapor pressure to pressure at the upper level and $\left(\frac{e}{B}\right)_o$ represents the ratio of vapor pressure to pressure at the lower level. By integral calculus the mean value $\left[Z\left(0.378\,\frac{e}{b}\right)\right]$ required in the formula is found to be:

$$(5)\qquad 5170\left(\frac{e}{B}\right)_o[1-10^{-0.0000317Z}]$$

Substituting the value of Z for all stations below the 5,000-foot level and solving gives a constant times $\left(\frac{e}{B}\right)_o$ which is used in place of $\left[Z\left(0.378\,\frac{e}{b}\right)\right]$ in the original equation and $\left(\frac{e}{B}\right)_o$ represents station observations. Substituting the value of $Z$ for Mount Hamilton in expression (5) as an example:

$$5170\left(\frac{e}{B}\right)_o[1-10^{-(0.0000317)(787.4)}]=288.796\left(\frac{e}{B}\right)_o$$

For stations above the 5,000-foot level, the correction must be obtained in terms of station observations $\left(\frac{e}{B}\right)$, instead of $\left(\frac{e}{B}\right)_o$.

$$(6)\qquad \left(\frac{e}{B}\right)_o=\frac{e}{B}(10^{0.0000317Z})$$

and substituting in (5)

$$(7)\text{ mean value of } Z\left(0.378\,\frac{e}{b}\right)=5170\left[\left(\frac{e}{B}10^{0.0000317Z}\right)\right][1-10^{-0.0000317Z}]$$

Substituting the value of $Z$ for each station and solving gives a constant times $\left(\frac{e}{B}\right)$ which is used in place of $Z\left(0.378\,\frac{e}{B}\right)$ in the original equation and $\left(\frac{e}{B}\right)$ represents station observations.

In this manner all of the values to be substituted in the hypsometric formula (3) were obtained. Substitutions in the case of Mount Hamilton, elevation 4,212.6 feet, $Z=787.4$ feet, follow as an example:

$$K'\log_{10}\frac{B_o}{B}=787.4-288.796\left(\frac{e}{B_o}\right)-0.803-0.03$$

It is obvious that no single table giving values of $B$ (pressure at 5,000 feet in the above example) can be constructed for changing values of $K'$, $B_o$, and $e$. Therefore, reduction tables for dry air were constructed omitting the correction for vapor pressure $\left(-288.796\,\frac{e}{B_o}\right)$ in the above case. Separate tables were constructed giving corrections for vapor pressure to be applied to the reduced pressures for dry air. These corrections are independent of variations in station pressure and were constructed from the following formulae:

For stations below the 5,000-foot level—

Let $B_o$ = station pressure.
$e$ = vapor pressure at the station elevation.
$K'$ = barometric constant corrected for temperature.
$B$ = pressure at 5,000 feet uncorrected for vapor pressure.
$B'$ = pressure at 5,000 feet corrected for vapor pressure.
$Z'$ = Z corrected for both gravity terms.
$X$ = the constant in vapor pressure correction term.

Then

$$K'\log_{10}\frac{B_o}{B'}=Z'-X\frac{e}{B_o}\text{ and }K'\log_{10}\frac{B_o}{B}=Z'$$

Subtracting

$$(\log B_o-\log B')-(\log B_o-\log B)=\frac{Z-X\frac{e}{B_o}}{K'}-\frac{Z'}{K'}$$

$$\log B'-\log B=\frac{Xe}{B_oK'}\text{ and }B'=B\left(10^{\frac{Xe}{B_oK'}}\right)$$

The correction desired for vapor pressure is $B'-B$,

$$(8)\qquad B'-B=B\left(10^{\frac{Xe}{B_oK'}}\right)-B$$

Vapor pressure corrections ($B'-B$) which are to be applied to the reduced pressure for dry air are determined by three variables, viz, vapor pressure, mean temperature, and station pressure. For all stations used in this study a range of 2.5 inches in station pressure will not change the correction in the third decimal place and thus average station pressure can be used as a constant for the computation. Mean temperature changes below 60° affect only the fourth decimal place of the correction but changes above 60° in mean temperature may change the correction by 0.001 inch, particularly at vapor pressures above 0.500 inch. By selecting 60° as a constant mean temperature, the corrections were computed for average station pressure for all values of vapor pressure. The corrections will not be in error more than 0.001 inch in extreme cases and exact to one thousandth of an inch for the majority of cases. This approximation is justifiable in order that the work of reducing barometers at the various stations may be simplified. After the correc-

tions were computed the vapor pressures were converted to dew point for greater ease in handling the observational data.

For stations above the 5,000-foot level, the formula for vapor pressure correction reduces to:

$$(9) \qquad B_o' - B_o = B_o\left(10^{-\frac{X_e}{BK'}}\right) - B_o$$

Where

$B_o'$ is the pressure at the 5,000-foot level corrected for vapor pressure.

$B_o$ is the pressure at the 5,000-foot level uncorrected for vapor pressure.

$B$ is the station pressure.

The corrections computed from the above formula are of negative sign and are to be applied to the reduced pressure.

The barometer reduction tables for dry air were computed to give values of $B_o - B$ at intervals of each 10° F. temperature from −20 to 100 and intervals of one-tenth inch of station pressure over a range of 2.400 inches. These tables allow easy interpolation. The value of $B_o - B$ and the dew point correction are both added to station pressure to obtain the pressure at the 5,000-foot level.

The values of $B_o - B$ for dry air at a given temperature are linear with respect to station pressure. Because of this fact a method for rapid computation of the tables was used. It was only necessary to compute an exact value to 4 decimals for each 10° of temperature and the lowest station pressure desired, then compute a similar value for a hypothetical pressure 10 inches higher, subtract the former from the latter, point off the proper decimals for intervals of one-tenth inch and add this value repeatedly to the first value, using an adding machine. Subtotals were taken between each addition and these were the values of $B_o - B$ in intervals of one-tenth inch station pressure for a given temperature.

*Example* (Mount Hamilton):

$$K' \log_{10}\frac{B_o}{B} = 787.4 - 288.796\left(\frac{e}{B}\right)_o - 0.803 - 0.03$$

For dry air the correction for vapor pressure is neglected and the remainder is combined:

$$K' \log_{10}\frac{B_o}{B} = 786.6, \text{ transposing } B = \frac{B_o}{\text{antilog}\left(\frac{786.6}{K'}\right)}$$

Dividing 786.6 by 60121.8 the value of $K'$ at 30°

$$B = \frac{B_o}{\text{antilog } (0.013083)}$$

It is desired to construct the table at intervals of one-tenth inch from the lowest station pressure of 24.400 inches, then,

$$B = \frac{24.400}{\text{antilog } (0.013083)}$$

, log 24.400 = 1.387390
− .013083
antilog 1.374307 = 23.6759
pressure at 5,000 feet

Similarly for a hypothetical pressure of 34.40 inches,

$$B = \frac{34.400}{\text{antilog } (0.013083)}$$

, log 34.400 = 1.536558
− .013083
antilog 1.523475 = 33.3792
pressure at 5,000 feet

For 34.40 inches $B_o - B = 34.400 - 33.3792 = 1.0208$
For 24.40 inches $B_o - B = 24.400 - 23.6759 = .7241$
subtracting .2967

Dividing by 100 to obtain the change for each one-tenth inch gives 0.002967 and adding this value repeatedly to 0.7241 gives the values of $B_o - B$ for 30° in intervals of one-tenth inch station pressure from 24.400.

| $B_o$ | $B_o - B$ | |
|---|---|---|
| 24.400 | 0.724100 | |
| | .002967 | |
| 24.500 | .727067s | |
| | .002967 | only three |
| 24.600 | .730034s | decimal places used. |
| | .002967 | |
| 24.700 | .733001s | |
| | etc. | |

It is necessary now to devise some means for securing the mean temperature of the air column between station elevations and the 5,000-foot plane. Stations over the plateau whose elevations are not far distant from the 5,000-foot level were selected purposesly in order to minimize the error when an arbitrary mean temperature of the air column is assumed.

The arbitrary mean temperature expressed by the value

$$\frac{\text{current temperature} + \text{temperature 12 hrs previous}}{2}$$

was graphed using averages of many hourly temperatures over a period of time. It was found that the curve is at a maximum between 1 and 2 a.m. and p.m., and a minimum between 7 and 8 a.m. and p.m. local time. It is entirely out of phase with the diurnal variation of surface temperature and undoubtedly out of phase with the mean temperature of a relatively short air column. A graph of Mount Weather temperatures at 1,500 feet above the surface indicates that the diurnal variation of mean temperature for this layer at least is in phase with the surface temperature but of less amplitude. The temperature records at Drexel, Nebr., (5) "show that the diurnal phase in the free air is not greatly different from that at the surface, but that the amplitude diminishes to about 1° C. at 1,500 meters, remaining practically unchanged from that level up to an altitude of 3,500 meters. * * * Naturally the diurnal variation is greater in clear than in cloudy weather * * *".

It would be better, therefore, to use an arbitrary mean computed from current and previous temperatures which would have a diurnal variation in phase with the surface temperature but of less amplitude. A curve with such characteristics can be obtained by the formula:

(2 × current temperature + Temperature 4 hours previous + Temperature 12 hours previous) ¼

Although the advantages of such a mean temperature argument are recognized, yet for simplicity the mean temperature used in sea-level reductions should be used in reductions to the 5,000-foot level. Therefore, the mean of the current temperature and temperature 12 hours previous was used in constructing a series of synoptic maps for the 5,000-foot level.

In attempting to reduce station pressures downward to the 5,000-foot level as well as upward to this level, an arbitrary mean temperature must be corrected, increasing it for downward reductions and decreasing it for upward reductions. In the absence of aerological data over the plateau, the average lapse rates were computed from Bigelow's Tables No. 34, volume II, Report of the Chief of the Weather Bureau 1900–1901. From these tables the vertical temperature rise or fall was interpolated between each station elevation and the 5,000-foot level for each month of the year and reduced to a mean correction for applying to the arbitrary mean temperature (see table 2).

### THE REDUCTION OF THE BAROMETRIC PRESSURE TO THE 5,000-FOOT LEVEL FOR CALGARY, CANADA

The elevation of Calgary, 3,389 feet, is high enough to make reductions of pressure to the 5,000-foot level with reasonable accuracy. All other Canadian stations reporting regularly have a lower elevation and cannot be used successfully with this method.

Tables were prepared for reducing the sea-level pressure, which is given in the signal reports, backwards to the true station pressure and then reducing this station pressure to the 5,000-foot level. Assuming that Calgary at present uses Bigelow's original table for reduction to sea-level, a table was constructed for the reduction backwards from that given on page 968 vol. 2 of the Chief's Report 1900–1901. This table, taken from Bigelow, gave true "station pressure" for the elevation 3,389 feet. A second table was constructed for the reduction from 3,389 feet to the 5,000-foot level using the same method as has already been described with the exception that average humidity values, page xlviii Smithsonian Meteorological Tables, were incorporated in the computations. In preparing these 2 tables it was discovered that they could be accurately combined into 1 table and this was done. The 5,000-foot pressures obtained from the latter table, using as arguments the mean 12-hourly temperatures and the sea-level pressures from the "signal" reports, are thus reasonably accurate. It is intended that a copy of the Calgary reduction table be supplied to stations where the 5,000-foot pressure maps are to be prepared so that the reduction can be accomplished after receipt of the Calgary report.

### THE REDUCTION OF BAROMETRIC PRESSURE TO THE 5,000-FOOT LEVEL FOR INTERMEDIATE AIRWAYS STATIONS EQUIPPED WITH ANEROID BAROMETERS

With few exceptions, intermediate airways stations over the Plateau report station pressure in the hourly weather sequences. Such pressures are not readily comparable, and are valueless to meteorologists and pilots except to show short period pressure changes. If the pressures obtained from aneroid barometers could be successfully reduced to the 5,000-foot level over the Plateau and thus entered in the sequence observations, they could be used to supplement the readings from mercurial barometers. All pressures at intermediate stations would be comparable and their value for indicating short period pressure changes would not be impaired. They would be particularly valuable in locating ill-defined wind-shift lines.

It is rare that the elevation of an intermediate airway station is known with sufficient accuracy for work in barometry. It may be possible to have levels run to all airways stations at some future time. For the present, however, the plan is to "adopt" an elevation for each station after every effort has been made to obtain the true elevation. This was done for a number of stations in Nevada, Utah, Idaho, and Montana, and the reduction computed to the 5,000-foot level to two decimal places. Average humidity was incorporated in the tables.

It is known that some aneroid barometers drift from their true setting over a period of time and that this error cannot be accurately determined except by comparison with a mercurial barometer at the station. Mercurial barometers are not ordinarily available to make such comparisons. However, periodical comparisons of reduced pressures from intermediate stations can be made with surrounding 5,000-foot pressures reported by stations with mercurial barometers at times when the maps are "flat" and upper-air winds are gentle. A correction can be determined for each station equipped with an aneroid barometer and instructions issued to such stations to apply the correction to all readings. A correction obtained in this manner will in reality be approximately the sum of two unknown corrections, i.e., a removal correction to the adopted elevation, and an instrumental error correction. If mercurial barometers are installed at some of the intermediate stations and elevations accurately determined, new tables based upon the true station elevation would be computed.

### SYNOPTIC MAPS FOR THE 5,000-FOOT LEVEL

Isobaric charts for the 5,000-foot level were prepared for the month of April 1932 using data for 38 high-altitude stations, 30 of which were equipped with mercurial barometers. One of the charts is shown in figure 1 in comparison with the sea-level chart. The upper-air winds for the 6,000-foot level were placed on each map and were in good agreement with the isobars. Pressure gradients were not so pronounced on the 5,000-foot maps as the sea-level maps. Poorly defined centers of low pressure were more easily traced from day to day over the Plateau on the 5,000-foot maps than on the sea-level maps. The "heat low" in the California valleys at sea level was not found on the 5,000-foot maps. Secondary depressions over southern Utah on the sea-level charts were not found on the 5,000-foot maps.

The sea-level maps should, of course, be continued, but supplemented by 5,000-foot pressure maps for the Plateau. The latter maps will be quite useful in locating poorly defined fronts which move in from the Pacific Ocean. The pressure data for this level would be useful in drawing streamlines on the proper upper air wind chart and such lines could be extended over the plains region with some degree of confidence.

The authors wish to acknowledge the assistance given in the preparation of this paper by Mr. L. P. Harrison, of the Aerological Division of the Weather Bureau, and the useful suggestions given by Mr. Albert W. Cook. of the Weather Bureau office, San Francisco, Calif.

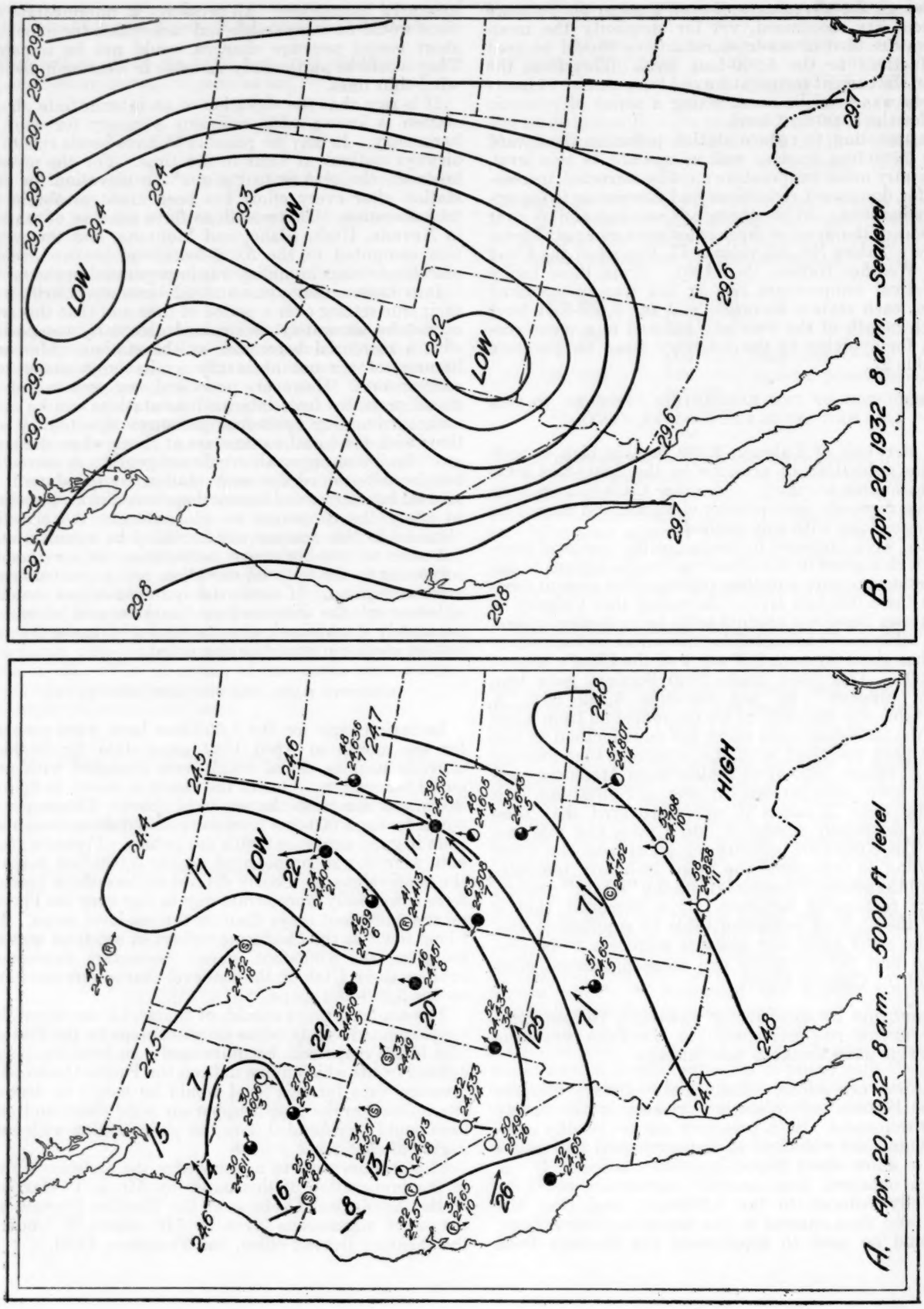


FIGURE 1.—Isobaric chart for the 5,000-foot level as compared with the sea-level chart for 8 a.m., April 20, 1932. Upper-air winds for the 6,000-foot level are shown on chart A

TABLE 1.—*Constants used in hypsometric equation for the various stations*

| Stations | Elevation | $Z$ | $Z\left(0.378\frac{e}{b}\right)$ | $Z\left(\frac{g_o-g_l}{g_o}\right)$ | $g_l$ | $Z\left(\frac{Z+2h_o}{R}\right)$ |
|---|---|---|---|---|---|---|
| Albuquerque, N.Mex. | 4,971.7 | 28.3 | $10.702\left(\frac{e}{b}\right)^2$ | 0.027 | (1) | 0.01 |
| Amarillo, Tex. | 3,614.3 | 1,385.7 | $497.354\left(\frac{e}{b}\right)^2$ | 1.286 | (1) | .57 |
| Baker, Oreg. | 3,470.6 | 1,529.4 | $546.055\left(\frac{e}{b}\right)^2$ | .102 | (1) | .62 |
| Bend, Oreg. | 3,632.2 | 1,367.8 | $491.305\left(\frac{e}{b}\right)^2$ | .181 | (1) | .56 |
| Blue Canyon, Calif. | 5,275.5 | 275.5 | $106.045\left(\frac{e}{b}\right)^2$ | .157 | (1) | .13 |
| Burns, Oreg. | 4,211.7 | 788.3 | $289.106\left(\frac{e}{b}\right)^2$ | .137 | (1) | .35 |
| Calgary, Alberta | 3,389.0 | 1,611.0 | ---------- | −.945 | (1) | .645 |
| Cheyenne, Wyo. | 6,143.8 | 1,143.8 | $447.948\left(\frac{e}{b}\right)^2$ | .458 | (1) | .61 |
| Denver, Colo. | 5,331.7 | 331.7 | $126.696\left(\frac{e}{b}\right)^2$ | .345 | 979.612 | .004 |
| Elko, Nev. | 5,076.5 | 76.5 | $29.01\left(\frac{e}{b}\right)^2$ | .033 | (1) | .04 |
| El Paso, Tex. | 3,915.7 | 1,084.3 | $393.385\left(\frac{e}{b}\right)^2$ | 1.721 | 979.109 | .056 |
| Grand Junction, Colo. | 4,602.2 | 397.8 | $147.862\left(\frac{e}{b}\right)^2$ | .422 | 979.629 | .01 |
| Helena, Mont. | 4,123.7 | 876.3 | $320.333\left(\frac{e}{b}\right)^2$ | −.043 | (1) | .383 |
| Independence, Calif. | 3,957.3 | 1,042.7 | $378.931\left(\frac{e}{b}\right)^2$ | .823 | (1) | .447 |
| Lander, Wyo. | 5,372.0 | 372.0 | $142.366\left(\frac{e}{b}\right)^2$ | .273 | 979.911 | .01 |
| Modena, Utah | 5,473.1 | 473.1 | $181.682\left(\frac{e}{b}\right)^2$ | .333 | (1) | .238 |
| Mount Hamilton, Calif. | 4,212.6 | 787.4 | $288.796\left(\frac{e}{b}\right)^2$ | .803 | 979.658 | .03 |
| Pocatello, Idaho | 4,477.6 | 522.4 | $229.651\left(\frac{e}{b}\right)^2$ | .126 | (1) | .258 |
| Pueblo, Colo. | 4,806.0 | 194.0 | $72.897\left(\frac{e}{b}\right)^2$ | .131 | (1) | .091 |
| Rapid City, S.Dak. | 3,259.0 | 1,741.0 | $616.988\left(\frac{e}{b}\right)^2$ | .228 | (1) | .688 |
| Reno, Nev. | 4,400.4 | 599.6 | $221.379\left(\frac{e}{b}\right)^2$ | .256 | (1) | .27 |
| Rock Springs, Wyo. | 6,374.42 | 1,374.42 | $545.367\left(\frac{e}{b}\right)^2$ | 1.132 | 979.727 | .09 |
| Roswell, N.Mex. | 3,565.5 | 1,434.5 | $513.898\left(\frac{e}{b}\right)^2$ | 1.541 | (1) | .588 |
| Salt Lake City, Utah | 4,226.6 | 773.4 | $283.833\left(\frac{e}{b}\right)^2$ | .673 | 979.812 | .029 |
| Sandberg, Calif. | 4,523.3 | 476.7 | $176.814\left(\frac{e}{b}\right)^2$ | .462 | (1) | .22 |
| Sheridan, Wyo. | 3,790.2 | 1,209.8 | $436.865\left(\frac{e}{b}\right)^2$ | .514 | 980.248 | .07 |
| Siskiyou Summit, Oreg. | 4,530.0 | 470.0 | $174.332\left(\frac{e}{b}\right)^2$ | .147 | (1) | .23 |
| Tonopah, Nev. | 6,089.5 | 1,089.5 | $427.917\left(\frac{e}{b}\right)^2$ | 1.253 | 979.443 | .06 |
| Winnemucca, Nev. | 4,343.9 | 656.1 | $241.749\left(\frac{e}{b}\right)^2$ | .553 | 979.838 | .02 |
| Winslow, Ariz. | 4,882.5 | 117.5 | $44.152\left(\frac{e}{b}\right)^2$ | .111 | (1) | .06 |

[1] Value for local gravity not known: $Z\left(\frac{g_o-g_l}{g_o}\right)$ taken as equal to $Z(.00264\cos 2\phi - 0.000007\cos^2 2\phi + 0.000045)$.

[2] $\left(\frac{e}{b}\right)$ refers to ratio of vapor pressure to total pressure at the station.

TABLE 2.—*Corrections to be applied to surface mean-temperature arguments to allow for average vertical temperature gradients*

| Stations | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Albuquerque | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Amarillo | −1.4 | −1.5 | −1.6 | −1.9 | −2.0 | −2.4 | −2.2 | −2.3 | −2.0 | −1.8 | −1.6 | −1.5 | −1.9 |
| Baker | −2.6 | −3.1 | −2.8 | −3.0 | −4.8 | −4.4 | −2.8 | −3.2 | −2.5 | −2.2 | −2.9 | −3.9 | −3.2 |
| Bend | −2.4 | −2.9 | −2.8 | −2.8 | −4.5 | −4.2 | −2.6 | −3.0 | −2.4 | −2.0 | −2.9 | −3.3 | −3.0 |
| Blue Canyon | +.5 | +.4 | +.3 | +.4 | +.3 | +.4 | +.3 | +.3 | +.3 | +.3 | +.5 | +.3 | +.4 |
| Burns | −1.4 | −1.3 | −1.5 | −1.5 | −2.1 | −2.0 | −1.3 | −1.5 | −1.2 | −1.1 | −1.6 | −1.7 | −1.5 |
| Cheyenne | +1.6 | +1.1 | +1.7 | +1.9 | +1.7 | +1.6 | +1.6 | +1.6 | +1.5 | +1.6 | +2.0 | +2.0 | +1.7 |
| Denver | +.2 | 0 | +.3 | +.5 | +.5 | +.4 | +.4 | +.5 | +.4 | +.4 | +.3 | +.4 | +.4 |
| Elko | +.1 | +.1 | +.2 | +.2 | +.2 | +.2 | +.1 | +.1 | +.1 | +.1 | +.2 | +.2 | +.2 |
| El Paso | −1.5 | −1.2 | −1.3 | −1.5 | −1.7 | −1.5 | −1.9 | −2.0 | −1.9 | −1.4 | −1.4 | −1.5 | −1.6 |
| Grand Junction | −.2 | 0 | −.3 | −.5 | −.6 | −.5 | −.6 | −.6 | −.7 | −.5 | −.5 | −.5 | −.5 |
| Helena | −1.6 | −1.5 | −1.6 | −1.6 | −1.7 | −1.7 | −1.4 | −1.2 | −1.2 | −1.2 | −1.5 | −1.9 | −1.5 |
| Independence | −1.4 | −1.1 | −1.3 | −1.3 | −1.4 | −1.4 | −1.2 | −1.4 | −1.2 | −1.2 | −1.5 | −1.5 | −1.3 |
| Lander | +.8 | +.5 | +1.0 | +.7 | +.9 | +.9 | +.8 | +.6 | +.7 | +.7 | +1.0 | +1.2 | +.8 |
| Modena | +.6 | +.4 | +.6 | +.8 | +.8 | +.9 | +.9 | +.8 | +.7 | +.7 | +.9 | +.7 | +.7 |
| Mt. Hamilton | −1.1 | −.9 | −1.1 | −1.0 | −1.0 | −1.0 | −.8 | −1.0 | −.9 | −.9 | −1.2 | −1.2 | −1.0 |
| Pocatello | −.8 | −.5 | −.8 | −.8 | −1.0 | −1.0 | −.8 | −.7 | −.8 | −.7 | −.9 | −1.1 | −.8 |
| Pueblo | −.2 | −.1 | −.2 | −.3 | −.2 | −.2 | −.2 | −.2 | −.2 | −.2 | −.2 | −.2 | −.2 |
| Rapid City | −1.2 | −1.2 | −1.4 | −2.5 | −2.6 | −2.5 | −2.4 | −1.8 | −2.1 | −2.2 | −.9 | −1.7 | −1.9 |
| Reno | −1.0 | −.7 | −1.0 | −1.0 | −.9 | −.8 | −.7 | −.7 | −.8 | −.9 | −1.0 | −.8 | −.9 |
| Rock Springs | +2.2 | +1.6 | +2.2 | +2.5 | +2.6 | +2.2 | +2.3 | +2.4 | +2.0 | +2.4 | +3.3 | +3.0 | +2.4 |
| Roswell | −1.8 | −1.5 | −1.7 | −2.0 | −2.1 | −2.3 | −2.1 | −2.5 | −2.3 | −1.8 | −1.8 | −1.8 | −2.0 |
| Salt Lake | −.6 | 0 | −.5 | −1.0 | −1.0 | −1.4 | −1.1 | −1.0 | −1.0 | −.9 | −1.0 | −1.0 | −.9 |
| Sandberg | −.6 | −.5 | −.6 | −.6 | −.6 | −.7 | −.4 | −.7 | −.6 | −.4 | −.7 | −.8 | −.6 |
| Sheridan | −1.7 | −1.3 | −1.5 | −1.9 | −2.2 | −2.1 | −1.7 | −1.3 | −1.4 | −1.6 | −1.3 | −2.2 | −1.7 |
| Siskiyou Smt. | −.8 | −.8 | −.9 | −.8 | −1.1 | −1.1 | −.8 | −.8 | −.8 | −.8 | −.7 | −.9 | −.9 |
| Tonopah | +1.8 | +1.5 | +1.6 | +1.8 | +1.6 | +1.9 | +1.5 | +1.6 | +1.6 | +1.6 | +2.1 | +1.8 | +1.7 |
| Winnemucca | −1.1 | −.8 | −1.0 | −1.0 | −1.2 | −1.1 | −.9 | −.9 | −.9 | −.9 | −1.1 | −1.0 | −1.0 |
| Winslow | −.2 | −.2 | −.1 | −.2 | −.2 | −.3 | −.3 | −.3 | −.2 | −.2 | −.2 | −.2 | −.2 |

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# THE CHARACTER AND MAGNITUDE OF THE DENSE DUST-CLOUD WHICH PASSED OVER WASHINGTON, D.C., MAY 11, 1934

By IRVING F. HAND

[Weather Bureau, Washington, June 1934]

The dense dust-cloud which passed over Washington May 11, 1934, was noteworthy not only because observations showed a higher dust content of the atmosphere than ever has been measured by this Bureau before, but also because of its brief duration.

Unfortunately, on the morning of the 11th, when the cloud was first noticed, our Owens dust counter (1) was undergoing repairs in the machine shop and observations could not be taken until shortly after noon. Table 1 gives the results of these counts and also of similar measurements made on the two following days.

TABLE 1.—*Dust counts of May 11–13, inclusive, with auxiliary data*

| Date and time | Location | Height, meters | Number of particles per cc | Average diameter of particles (reduced to cubes) | Visibility (miles) |
|---|---|---|---|---|---|
| 1934 | | | | | |
| May 11 | | | * | μ | |
| 1:15 p.m. | American University | 134 | 9,450 | 1.0 | ¼ |
| 3:00 p.m. | Key Bridge, Georgetown | [1] 20 | 12,180 | 1.0+ | 1/16–¼ |
| 3:22 p.m. | American University | 134 | 11,445 | 1.0+ | ¼ |
| 10:00 p.m. | do | 134 | 3,150 | 1.0− | [2] 10 |
| May 12 | | | | | |
| 5:00 a.m. | do | 134 | 4,620 | 0.9 | 20 |
| 8:00 a.m. | do | 134 | 903 | .9 | 30 |
| May 13 | | | | | |
| 5:00 a.m. | Harrisonburg, Va | [1] 370 | 1,155 | .9 | [1] 10 |
| 9:10 a.m. | Fisher's Gap, Va. (Blue Ridge) | [1] 1,000 | 693 | .8 | [1] 10 |
| 1:25 p.m. | No. 2 C.C.C. Camp, Va | [1] 1,100 | 609 | .8 | [1] 10 |
| 2:20 p.m. | Criglersville, Va | [1] 250 | 1,365 | .9 | [1] 10 |

[1] Estimated; in case of heights, topographic maps were consulted.
[2] Distance lights could be seen.

The largest number of atmospheric dust particles previously measured by this Bureau in Washington is 7,077 (2), so the value of 12,180 obtained at 3 p.m. on the 11th exceeds this previous maximum by 72 percent. After the passage of the main cloud, the dust drifted over the city in patches, as shown by the variation in counts made on the 12th. Measurements made in Virginia on the 13th show an unusually large number of particles on the Blue Ridge, but as no previous counts have been made in the Shenandoah Valley, we can only assume that the number there was larger than would be expected in free country air under ordinary circumstances. The size of the particles obtained on the Blue Ridge averaged considerably larger than previously had been measured there.

In order to simplify computation, the average volume of the particles has been estimated in cubical form. Dust particles generally have been assumed to be spherical in shape; examination, however, shows them to be in all manner of shapes with flat forms predominating. These forms have a tendency to deplete solar radiation receipt to a greater extent than would spherical particles of equal mass as flat forms tend to fall in a direction at normal incidence to the side with the greatest area.

From aerological and other sources, we have estimated the height of this cloud as 2 kilometers. Adopting the average vertical distribution of dust as determined from airplane observations (3), we find that the number of particles that actually were in a vertical column 2 kilometers high closely approximates the number that would be in a column 1 mile high having throughout the same dust density as that actually near the surface of the earth. Computations therefore have been made on this latter basis and in using either of the accompanying formulae, $H_m$ should always be reduced to the height of even distribution.

Computing the weight of the dust, we have given $1.64\times10^5$ as the number of particles per cubic inch $6.1\times10^{-14}$in$^3$ as the average volume of the particles; 2.2; as the density and the height 1 mile. To determine the number of cubic inches in a mile, we have simply, $12^3\times 5{,}280^3=2.54\times10^{14}$. Then $(1.64\times10^5)\ (6.1\times10^{-14})=10^{-8}$, the number of cubic inches of dust in 1 cubic inch of air. Also $(2.54\times10^{14})\ (1.64\times10^5)$ gives $4.17\times10^{19}$, or the number of particles per cubic mile; or $(2.54\times10^{14})\ (10^{-8})=2.54\times10^6$, or the number of cubic inches of dust in one cubic mile.

Reducing to cubic feet in a cubic mile, $(2.54\times10^6)/(1.73\times10^3=1.47\times10^3$. Multiplying together the weight of a cubic foot of water, the density of this dust and the number of cubic feet of dust in a cubic mile and dividing by the weight of a short ton, we have

$$\frac{62.4\times2.2\times1.47\times10^3}{2\times10^3}=101$$

as the number of short tons over each square mile.

As would be expected, the diminution of solar radiation owing to absorption and scattering was enormous; amounting to about 75 percent. A value of 0.29 gram-calorie per minute per square centimeter of normal surface, received from the sun near noon with a comparatively water-free sky and through an air mass of 1.07, is exactly 25 percent of the normal for this air mass.

As Dr. William J. Humphreys has pointed out in his Physics of the Air, a continuation of a dust blanket of this magnitude would shortly result in ice-age conditions. Fortunately, while this cloud had considerable area, it was at a low level and most of it was carried to the surface with the first precipitation; much of it at sea, as rain did not fall in Washington until the 14th, and the cloud had a general easterly trend.

That this storm was of wide-spread area is evidenced by reports from other stations. Mr. Eric R. Miller, in charge of the Weather Bureau station at Madison, Wis., reports:

> At Madison only 0.82 inch of rain fell during the month, of which only 0.77 fell on the night of the 12th–13th. Much blowing dust from the Dakotas, Minnesota, and western Wisconsin. Worst dust storm on record on 10th, visibility less than 1 mile. Dust entered smallest crevices.

Unfortunately, cloudy skies prevented solar observations on the 10th, but observations taken early on the 11th gave values less than 50 percent of normal. Observations taken at Lincoln, Nebr., on the 10th show greatly depleted radiation receipt, but to a lesser degree than at either Washington or Madison which leads one to believe that the greater portion of the dust came from points north of Nebraska.

Quantitative and qualitative analyses by mere visual inspection showed that the particles averaged larger than

usual and that the proportion of organic matter was considerably more than average. Minerals, loess, spores, plant-hairs, bits of decayed matter, glass, and transparent crystals were readily isolated and detected.

A flat beaker was placed on the roof of the solar radiation observatory at noon of the 11th, and taken down 24 hours later. Mr. M. E. Jefferson, of the Bureau of Chemistry and Soils, kindly consented to make a petrographic analysis of the contents of this beaker and his results are quoted herewith:

NOTE ON THE PETROLOGY OF THE DISTRICT OF COLUMBIA DUST STORM OF MAY 11, 1934

In connection with the observations on the dust storm discussed in the preceding paper, a sample of the dust was collected by Mr. I. F. Hand in an open beaker which was set out early on the 11th and taken in on the 12th at noon when the dust had practically disappeared from the air. The sample was examined under the petrographic microscope by immersion in the usual oils.

Quartz and gypsum were present in amounts great enough to be readily identified, while calcite was found in very small amounts in the form of small size particles. Orthoclase and microcline were identified and apparently showed no alterations. Quartz and feldspar were found to be clear and unstained. Mica was present but appeared altered at the edges to such an extent that identification was impracticable. It is apparently muscovite and biotite.

There was considerable isotropic material in the sample, none of which, however, could be definitely classified. Conchodial fragments had indices ranging from 1.45 to 1.60 and a few flat irregular fragments had less than 1.43, usually low.

The volcanic glass, hornblende, zircon, and tourmaline found by Alexander (4) in the Buffalo dustfall were not identified as such here.

Measurement of the particle size gave the range of diameter or length 0.001 mm to 0.13 mm with most of the mineral constituents in the range 0.005 to 0.04 mm. Winchell and Miller (5) found the range in the Madison dustfall to be 0.003 to 0.1 mm the quartz and feldspar in this case were stained with limonite and hematite. In the Buffalo storm Alexander reports lengths up to 0.05 mm. There is considerable opaque material of rather large particle size (0.01 to 0.1 mm) which we have made no attempt to identify.

The organic material present in this dust storm is much greater than that given by Alexander being at least 30 percent and consists of spores, stellate plant hairs, and vegetable fibers. No attempt was made to classify the spores and plant hair present. In several tests diatoms were recognized.

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Dr. Charles F. Brooks, Director, Blue Hill Meteorological Observatory, Harvard University, Hyde Park, Mass., transmits the following note from C. A. Chapman:

DUST FROM CIRCULAR GLASS PLATE 25 CM IN DIAMETER AT MOUNT WASHINGTON, MAY 11 AFTER EXPOSURE ALL DAY

Amount of dust on the plate —— 0.011 —— grams.

The dust is very fine and varies from 5–30 microns in diameter. The average grain size is 10 microns.

For the most part the individual particles are decidedly angular and show no signs of frosting.

The dust consists principally of quartz and feldspar which exist as clear colorless grains.

Several species of diatoms are present but no attempt was made to identify any of them. They occur as small, porous, plant-like forms.

Other minerals identified as occurring in small amounts were sericite, green chlorite, iron oxides, and several aggregate masses of very fine-grained amorphous material.

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# HOW A COMMERCIAL PILOT MAY CONTRIBUTE TO A PROGRAM OF AIR-MASS ANALYSIS BY OBSERVATIONS MADE DURING FLIGHT

By L. P. HARRISON

[Weather Bureau, Washington, D.C.]

The need for analyzing weather as a three-dimensional system rather than merely as a two-dimensional one, such as is exemplified by the customary synoptic charts, has, among other things, brought about the regular daily use of airplane observations to heights of 17,000 feet or over as a permanent adjunct of the weather service. The planes now employed in this service are few in comparison with those in commercial use, hence there exists the possibility of securing a valuable addition to the scheduled soundings by enlisting the aid of commercial air pilots to record and make available meteorological observations made during their flights over the airways, just as many years ago the aid of mariners was enlisted for the collection of meteorological observations made on commercial vessels plying the trade routes of the Seven Seas.

In requesting the cooperation of pilots for the development of a program along this line, we should ask them to make their observations from the viewpoint which has contributed most to modern meterology, viz, physical weather analysis and air-mass analysis. However, before we may detail the character of the observations desired, we must first make clear just what we mean by these terms.

The fundamental concept of this method of analysis is based on the realization that our weather is caused, in general, by the expenditure and transformation of stored atmospheric energy (gravitational potential, and thermal) with the attendant interplay between air masses of markedly contrasting temperatures which have come into juxtaposition after having moved away from different respective regions over which they have recently been at rest, or wandering for a length of time sufficient to permit the environments to bring them to a state in regard to temperature, moisture content, and other features, more or less typical of these regions for the given time of year. The individual air masses do not freely mix with one another but tend to remain separate with more or less sharply defined boundary surfaces, or surfaces of discontinuity between them. Not infrequently, if not ordinarily, it is found that relatively thin transition zones serve instead of distinctly marked surfaces of discontinuity. Usually, rather marked changes in the characteristics of the respective air masses are observable as one crosses a surface of discontinuity, for the air masses on their travels tend to retain the characteristics of temperature, moisture content, and other properties which are normal for the regions from which they orig-

72827—34——2

inated. However, the varied physiographic and other conditions along the course over which the body of air has traversed exert a profound modifying influence upon these characteristics, especially upon those in its lower portion. The formation of any of the forms of moisture condensation within the air mass, or their precipitation through it, likewise produce therein important deviations from the original distinguishing traits.

The surfaces of discontinuity we have already referred to are of great significance in air-mass analysis since, besides delimiting the extent of the air masses and their subdivisions, they frequently represent the loci wherein the transformation of energy, potential or latent, is initiated. If one were to make a series of airplane ascents periodically at a given locality, carrying suitable meteorological instruments, he would discover the atmosphere to be stratified and would observe the heights of the surfaces of discontinuity between the strata to be gradually becoming greater or less. Moreover, he would sometimes find that the distinctive meteorological qualities within each of the strata might be changing gradually as the latter moved bodily along with the wind; however, this is not necessary since not infrequently the air masses closely approximate to horizontal homogeneity in respect to these qualities. Since the surfaces of discontinuity are not level in general, some of them must intersect the surface of the earth. Where this occurs we have the phenomenon known as a "front", the passage of which over a place is attended ordinarily by well-marked changes in conditions of temperature, wind, etc.

With this very general statement of the immediate causes of our weather, we do not commit ourselves too specifically as to the details of the mechanism of the cyclone and anticyclone, but leave to the future the settlement of these questions.

At this point we may indicate the position that air-mass analysis holds among the principal steps leading up to and including forecasting of the weather. This may perhaps best be done by means of a synopsis such as the following:

1. *Weather observation.*—The observing of meteorological phenomena and the noting of data representing them.

2. *Physical weather analysis.*—A physical analysis of the state of the atmosphere and the activities going on within it. This consists of two parts:

(*a*) *Air-mass analysis.*—Identification and delimitation of air masses, that is, analysis of the magnitudes and distribution of characteristic properties and other significant meteorological elements of the air masses; classification of the air masses according to source-region and principal modifications due to trajectory over land and water surfaces; and determination of the position, structure, nature, etc., of the various fronts and surfaces of discontinuity (zones and layers of transition) or boundaries of the air masses.

(*b*) *Dynamical weather analysis.*—Analysis or diagnosis of the physical activities underlying given weather conditions, that is, a study of present and past weather situations to describe the nature of the activities, such as precipitation, cloudiness, definite relative motions of adjacent air masses, etc., which are occurring in the given weather situation and to determine the physical causes which are bringing and have brought these activities about.

In short, air-mass analysis is the determination of what air masses are present, how they are characterized, and where they are. Dynamical weather analysis is the determination of what the air-masses are doing and why they are doing it.

3. *Weather prediction.*—Forecasting the state of the weather at some future time on the basis of present and past weather situations.

(*a*) *Synoptic projection.*—The projection of the present and past configurations of air masses, pressure systems, etc., into the future, allowing for the nature, magnitudes, and distribution of the air masses, forces, etc., which are operating, and for any changes which may occur with place and time as a result of the various factors involved.

(*b*) *Dynamical weather projection.*—The projection from present and past configurations of air masses, pressure systems, weather conditions, activities, etc., into the future, and then the indication or description of the meteorological activities such as precipitation, temperature changes, etc., which must most probably occur.

For the processes of identification and delimitation of air masses, we require the determination of all the important conservative or semi-conservative qualities or attributes to be found in the atmosphere, such as specific humidity, potential temperature, equivalent potential temperature, and the like. These attributes of each respective type of air mass permit us to put a labeling tag, so to speak, upon each air mass and allow us to recognize a given air mass through the course of its vicissitudes. By means of continuous or periodic observations of the proper sort, we may note the progressive changes which occur. In order to satisfactorily describe and understand the nature of these changes, it is necessary for us to employ dynamically significant criteria. That is, it is not sufficient for us merely to study such directly observable quantities as pressure, temperature, and relative humidity, but we must also study quantities which may be computed in terms of those just mentioned and which have been deduced by means of mathematico-physical reasoning along the lines of dynamical meteorology from a minimum of suitable premises. The importance of this approach is seen in the fact that physical weather analysis on this basis will lead to a verification or disproval of the premises underlying the derivation of the relationships which are expressed numerically by the quantities in question. Thus, the outcome of this mode of attack will be a more nearly exact knowledge of the dynamics of the atsmosphere which is so essential to the elevation of weather forecasting from the present semi-physical methods to the desired mathematico-physical methods so successful in other fields.

We may now return to the question of how a commercial pilot may contribute to a program of air-mass analysis by observations made during flight. Observations made from a commercial airplane with the ordinary equipment carried thereon are of course limited in scope; however, worthwhile results may be so obtained. The main objectives in such cooperative effort would be:

1. The location of surfaces of discontinuities and fronts in space and time, with description of conditions on both sides of the discontinuities.

2. Determination of vertical motion in the atmosphere when detectable, and observation of accompanying phenomena.

3. Observations of conditions during occurrence of various phenomena such as icing of airplanes, development of clouds from a three-dimensional aspect over a period of time, etc.

For every phenomenon reported by a pilot there should always be given the following data:

(*a*) Geographical position (with respect to known towns or cities; or latitude and longitude).

(*b*) Date.

(*c*) Time of day (and standard meridian time used).

(*d*) Altimeter reading, expressed as height above sea level or above some specified point.

(*e*) The barometric pressure at which the altimeter would read zero altitude; place and time of take-off; temperature at surface at time of take-off.

(*f*) Temperature of the free air, read from a strut thermometer, at point of observation of phenomenon.

(*g*) General weather conditions at time of observation, including: Cloudiness—amount, kind, and heights of bases and tops of various cloud formations, if determined; precipitation—kind, intensity, greatest and lowest heights at which observable.

Some observations which are of assistance in attaining the first objective, viz, the location of surfaces of discontinuity and fronts, follow:

1. *Discontinuities in atmospheric turbidity, i.e., surfaces across which marked changes in turbidity are observable.*—(*a*) Haze layers; (*b*) dust layers; (*c*) tops and bases of stratiform clouds; (*d*) top of fog, etc.; giving in each case the cause of the turbidity, its thickness, horizontal extent, visibility, and measure of turbidity expressed preferably in some such scale of opalescent turbidity [1] as Bergeron has given in his well-known work, Über die Dreidimensional Verknüpfende Wetteranalyse, I, Geofysiske Publikasjoner, vol. V, Oslo, 1930.

2. *Thermal discontinuities.*—The airplane should carry a strut thermometer to detect such discontinuities. Due to various difficulties only inversions of temperature (i.e. increase of temperature with height) are easily detectable by means of a strut thermometer. Fronts also may be easily detectable thereby.

3. *Humidity discontinuities.*—Commercial airplanes usually are not equipped to measure relative humidity.

4. *Wind discontinuities.*—Marked shifts in wind direction, and rapid changes in speed with change in height or change in horizontal position are observable from mechanical effects on the flight of the airplane or from changes in the drift of the ship when the ground is visible. Squalls and wind-shift lines such as are encountered near cold fronts and in connection with thunderstorms, come under this heading.

As for the second objective mentioned above, there may be observed:

1. *Bumpiness.*—Bumpiness may be reported on a scale of 0–5, such as was given by W. H. Pick and G. A. Bull in Great Britain Meteorological Office Professional Notes No. 46, "A Note on Bumpiness at Cranwell, Lincolnshire," 1927; 0, no bumps; 1, slight bumps; 2, occasional bumps; 3, bumpy; 4, very bumpy; 5, exceptionally bumpy. Horizontal extent, nature of the terrain and accompanying phenomena, if noticeable, should also be given.

2. *Marked upward and downward large scale currents.*—These are most pronounced in spring and summer and usually in connection with cumulus and cumulo-nimbus clouds (thunderheads). Also with the squall-line attending cold fronts. Such currents are detectable by rapid vertical cloud motions and by differences in climbing or gliding speeds from the normal for the given flying conditions.

The third objective given above applies to miscellaneous phenomena, e.g.:

1. *Icing of airplane.*—Ice which accumulates on airplanes should be classified as (*a*) hard ice; (*b*) rime; (*c*) frost. Hard ice is essentially the same as glaze; however, it may be either clear or opaque (whitish). The thickness, physical appearance, place of formation, temperature of air, visibility in cloud (or rain) where formation occurred, rapidity of formation, etc., should also be given.

2. *Development of clouds.*—The aviator can frequently observe details in regard to the growth or disappearance of clouds not easily obtainable from ground observations. Such information may possibly be of value in the final analysis of what processes actually cause condensation of water vapor into clouds and subsequent precipitation.

In conclusion, it would appear feasible to prepare printed forms on which commercial pilots could indicate the pertinent phenomena observed during flights, and to develop a system whereby the pilot would turn in these reports to local weather observers at airports who would then forward them to the proper headquarters where studies would be made of the accumulated data. Such a cooperative effort might conceivably be of inestimable value in the long run to both parties concerned by virtue of the enhancement of our knowledge of the atmosphere and the improvement in forecasts.

The synopsis of weather analysis given earlier in the paper represents the consensus of opinion of officials at the Central Office of the Weather Bureau.

[1] The purpose of determining the opalescent turbidity is to obtain an approximate measure of the amount and fineness of the suspended solid material in the atmosphere which because it settles out so slowly is a semiconservative characteristic of air masses in general. A measure of the opalescent turbidity is, roughly speaking, a measure of the light-scattering power of the exceedingly fine solid particles which are suspended in the atmosphere. This measure is approximately inversely proportional to the visibility, provided that the observations of the latter are made so as to be independent of the distance, color, brightness, and albedo of the object viewed; the position of the sun with respect to the line of sight; the cloudiness; the color, brightness, and albedo of the sky and background, etc. To attain this end in a practical manner, Bergeron has laid down rules for selecting suitable objects, with instructions for making observations of visibility so that one may thus obtain a measure (approximate) inversely proportional to the opalescent turbidity. In this scheme, distant mountains and elevated objects are considered most suitable, provided that in making the scale of visibility the respective objects subtend equal angles at the eye of the observer no matter what their distance. The objects should not extend too high if it is desired to measure the horizontal visibility. The objects *must* be dark, preferably black. White objects, water, and brightly colored structures are precluded. Objects should not be viewed toward the sun, but preferably at right angles to the line from observer to sun, and not in twilight. Also, not under low thick clouds or fog, especially if the sky is largely clear. The nature and color of the objects so viewed, the relative positions of the sun, observer, object, and cloudiness, whether the object was shaded from the sun and sky largely clouded over, whether the object was illuminated and the sky largely clear, or whether other conditions prevailed in this respect, clarity of the details and contour of the object viewed, etc., should be stated with each observation; also any coloration observed due to the turbidity itself. (See also H. Koschmieder—Theorie der horizontalen Sichtweite, Beiträge zur Physik der freien Atmosphäre, Band XII, 1925, pp. 33–55, and 171–181.)

## A STATISTICAL ANALYSIS OF FOGS AT GREENSBORO, N.C., AIRPORT

By JOHN C, SCHOLL

[Angier, N.C., May 1934]

During the 4-year period, August 1929 to July 1933, inclusive, fog occurred at the Greensboro Airport 381 times. Of this number 4 began as dense and ended as light, 1 was dense from start to finish, 116 began as light but were dense some time, while the remaining 260 were light all the time. The average number per month of light and dense fogs for this period was 7.9 and 2.5, respectively.

Each of these 381 cases was, of course, the result of either general or local meteorological changes. The general conditions and changes favorable to fog are well known. However, many of these fogs unquestionably occurred as a result of purely local changes, some of which were probably very slight and seemingly insignificant. Consequently the results of this study are not entirely representative of the conditions which exist in any locality other than the Greensboro Airport.

Figure 1 substantiates the general opinion that both light and dense fogs are more prevalent in the winter months. It is believed that if data were available for a

sufficient number of years to produce acceptable monthly averages, the rise in line B for May would be ironed out. The same might be true for the small number of dense fogs in June.

Perhaps the most striking feature of figure 1 is the evidence of the appearance of radiation fogs during the usual months of their chief occurrence. In late summer and early autumn when this type of fog predominates it is noted that comparatively few fogs are heavy. Hence it appears that a relatively large number of frontal (a great portion of which occurred in the winter months), but comparatively few radiational, fogs became dense.

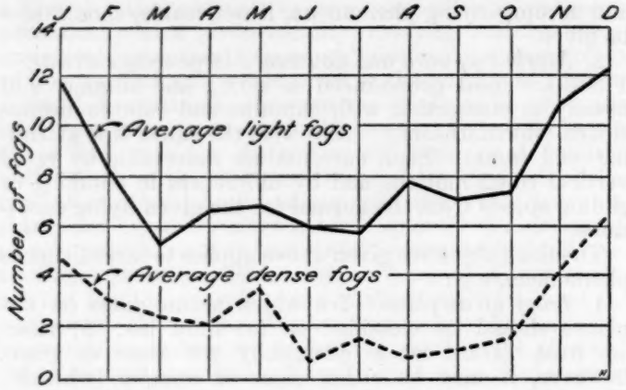


FIGURE 1.

One hundred and twenty of the one hundred and twenty-one dense fogs were at some time light and therefore are included in line A. Consequently line A actually shows all fogs, except one, that occurred during the period in question. Line B shows the fogs that some time were dense.

## BAROMETER

The barometric change during the existence of each of the 381 fogs, and similar data for the 2-hour period preceding each, were obtained. Diurnal variations were eliminated before the data were tabulated. The mean average hourly barometer change during the fogs was +0.0001 inch, and the mean average hourly change for the 2 hours preceding them −0.0010 inch. Through most of these fogs the barometer remained practically stationary, but for the 2 hours preceding them it generally fell slightly.

Figure 2 shows the deviations of the monthly station barometer averages from their mean.

Some relationship apparently exists between graphs 2 and 3. Line A (fig. 3) shows that in the months in which the station barometer is above the average the barometer change during fogs is below the average and vice versa, except in cases of March and September; and it is interesting that these are the more or less accepted dividing lines between summer and winter.

Line B (fig. 3) is somewhat similar to A, the chief difference being that the maximum fall occurred in March whereas this fall occurred in December in case of A. Then, too, January offers an additional exception in the case of B, in that the fall for this month is slightly below the mean. It is significant that in A and B the January fall is slight compared to the months that immediately precede and follow.

The tendency of A and B to fall in the winter months when frontal fogs predominate is believed to exist mostly because of the following two reasons:

First, HIGHS often during these months "park" for a considerable time along the Atlantic Seaboard, usually centered around Maryland or a little farther north. When this condition is present damp northeast winds are blown in for several days. This set-up quite naturally

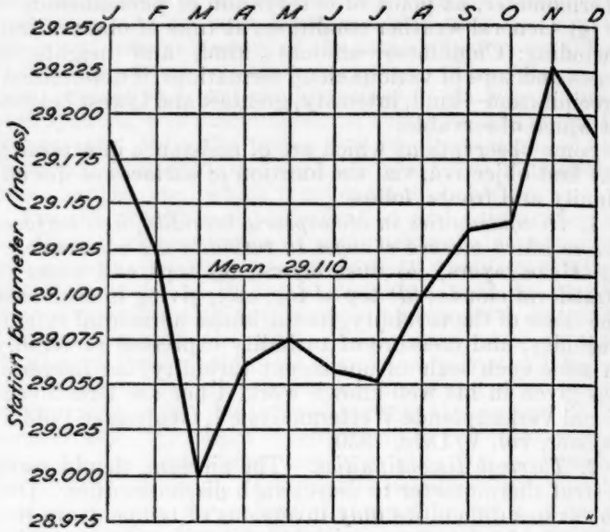


FIGURE 2.

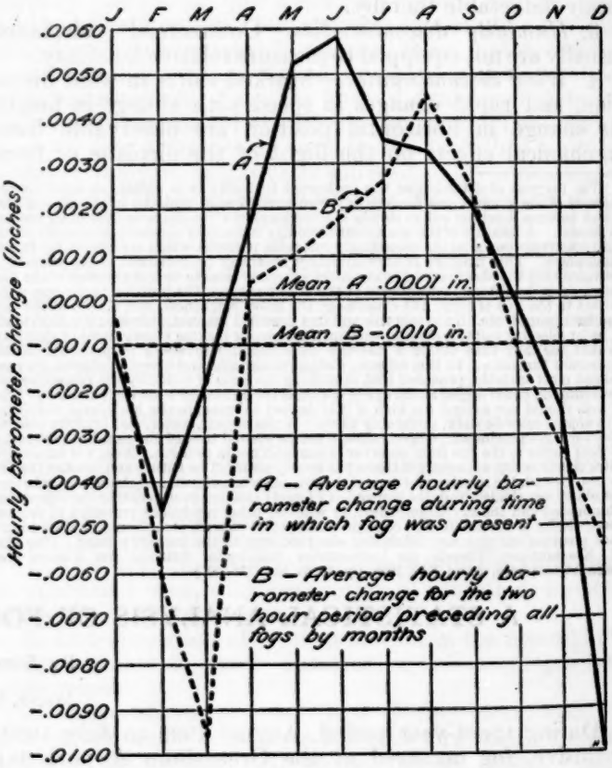


FIGURE 3.

is favorable to fog formation and the barometer obviously falls as the HIGH eventually recedes northeastward.

Second, moisture-laden air from some souther direction frequently blows in. Due to the fact that air around the surface of the ground in this time of year is relatively cold

a layer of this air, which has been blown in, is cooled below its dew point and thereby results in condensation in the form of fog.

In other words, the condition probably exists because, in one case, of the receding of a HIGH accompanied by predominating northeast winds, and in the other case by the approach of a LOW with resulting southerly winds.

The conclusion arrived at as a result of the barometer study is that, in general, the barometer tendency during and immediately preceding fog formation is to fall in months of high pressure and to rise in months of low pressure.

TABLE 1.—*Wind direction and velocity*

| | N. | NE. | E. | SE. | S. | SW. | W. | NW. | Calm |
|---|---|---|---|---|---|---|---|---|---|
| A | | | | | | | | | |
| January | 6 | 6 | 4 | 0 | 2 | 18 | 8 | 3 | 0 |
| February | 5 | 5 | 2 | 1 | 2 | 14 | 2 | 1 | 0 |
| March | 5 | 4 | 1 | 3 | 3 | 3 | 1 | 1 | 0 |
| April | 7 | 9 | 0 | 5 | 2 | 2 | 1 | 0 | 0 |
| May | 1 | 10 | 2 | 0 | 4 | 5 | 2 | 3 | 0 |
| June | 3 | 6 | 3 | 1 | 3 | 2 | 3 | 3 | 0 |
| July | 2 | 3 | 4 | 1 | 4 | 4 | 3 | 2 | 0 |
| August | 8 | 3 | 1 | 1 | 4 | 7 | 3 | 4 | 1 |
| September | 1 | 8 | 1 | 1 | 9 | 5 | 3 | 0 | 0 |
| October | 5 | 11 | 0 | 0 | 4 | 6 | 1 | 1 | 1 |
| November | 4 | 18 | 2 | 1 | 5 | 10 | 2 | 1 | 0 |
| December | 4 | 7 | 3 | 2 | 5 | 14 | 13 | 1 | 0 |
| Total | 51 | 90 | 23 | 16 | 47 | 90 | 42 | 20 | 2 |
| B | | | | | | | | | |
| January | 7 | 7 | 2 | 1 | 10 | 11 | 6 | 3 | 0 |
| February | 0 | 8 | 2 | 1 | 5 | 12 | 4 | 0 | 0 |
| March | 3 | 7 | 3 | 1 | 3 | 4 | 0 | 0 | 0 |
| April | 3 | 11 | 3 | 5 | 1 | 1 | 1 | 1 | 0 |
| May | 3 | 8 | 5 | 1 | 3 | 7 | 0 | 0 | 0 |
| June | 4 | 5 | 4 | 1 | 4 | 5 | 1 | 0 | 0 |
| July | 2 | 1 | 7 | 1 | 4 | 4 | 3 | 1 | 0 |
| August | 5 | 5 | 0 | 2 | 4 | 7 | 6 | 3 | 0 |
| September | 2 | 7 | 1 | 1 | 10 | 5 | 1 | 1 | 0 |
| October | 1 | 14 | 2 | 1 | 2 | 5 | 2 | 1 | 1 |
| November | 3 | 24 | 0 | 3 | 5 | 7 | 1 | 0 | 0 |
| December | 4 | 15 | 2 | 1 | 7 | 16 | 4 | 0 | 0 |
| Total | 37 | 112 | 31 | 19 | 58 | 84 | 29 | 10 | 1 |
| A | 13 | 24 | 6 | 4 | 12 | 24 | 11 | 5 | 1 |
| B | 10 | 29 | 8 | 5 | 15 | 22 | 8 | 3 | 0 |

(A) shows the prevailing wind direction during each of the 381 fogs. (B) shows the same thing for the 2-hour period preceding each case.
The lower lines contain the percentages of wind directions from the various directions during fogs (A) and for the 2-hours preceding fogs (B).

Table 1 shows the prevailing wind for all fogs during the period to be northeast and southwest (90 cases of each), and the prevailing direction for the 2 hours preceding fog formation to be northeast.

TABLE 2

| | Average hourly wind velocity | Average hourly wind velocity during fogs | Average hourly wind velocity for the 2 hours preceding fogs |
|---|---|---|---|
| January | 7.6 | 5.2 | 5.8 |
| February | 7.6 | 5.8 | 5.8 |
| March | 9.8 | 7.5 | 7.0 |
| April | 8.4 | 7.5 | 7.0 |
| May | 7.5 | 5.2 | 6.0 |
| June | 6.5 | 4.8 | 5.0 |
| July | 6.2 | 3.8 | 3.0 |
| August | 5.6 | 4.0 | 3.8 |
| September | 6.4 | 4.8 | 4.2 |
| October | 6.5 | 5.0 | 5.0 |
| November | 6.8 | 7.0 | 6.5 |
| December | 7.0 | 5.2 | 6.2 |
| Mean | 7.2 | 5.5 | 5.4 |

A vast majority of the fogs occurring in the months November, December, January, and February are unquestionably frontal. In November, A and B, particularly A (table 1) show a preponderance of northeast winds. Thus November seems to be the typical month in which fog forms largely from colder air being blown into a warmer area. During and immediately preceding fogs in December, January, and February southwest winds predominate. Thus it seems that in these months fogs form mostly due to relatively warm southwest winds blowing into a colder area, with a resulting temperature drop sufficient to cause the dew point to be reached.

No discussion will be made of table 1 in regard to the months in which radiational fogs chiefly occur, because this type of fog cannot occur unless there is very little air motion.

The abnormal month in table 2 is November. Every other month conforms to the accepted principle that fog usually forms with a lighter-than-normal wind velocity. However, during and just prior to the November cases this condition apparently did not exist. It is believed this exception was due to the fact that a great majority of the November fogs are accompanied by northeast winds, which usually are of greater velocity than the winds that generally accompany fogs.

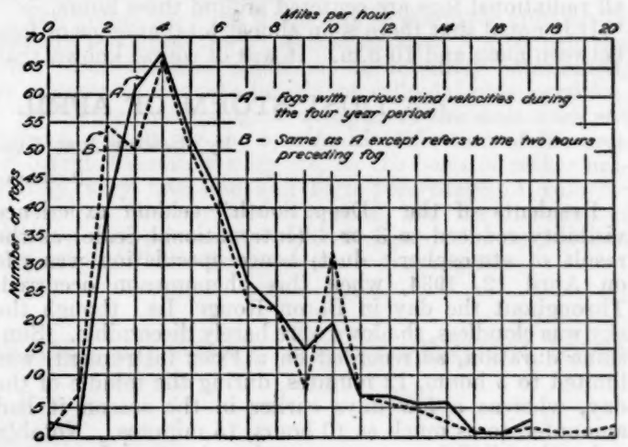


FIGURE 4.

Figure 4 shows that 4 miles an hour is the wind velocity at which fog is most likely to occur. This graph also substantiates the opinion that it is almost impossible for fog to form without some air motion A and B show an almost entire absence of cases occurring with a velocity of less than 2 miles an hour. The fact that fogs usually occur with light winds is, of course, too well known to require any discussion. Line A (fig. 4) further shows that there were three cases with an average hourly velocity of 17 miles an hour. Two of these fogs lasted only 1 hour each. However, on November 4, 1930, fog prevailed for 5 hours with this high velocity and was accompanied by a north wind.

TABLE 3.—*Temperature*

| | (A) | (B) | | (A) | (B) |
|---|---|---|---|---|---|
| January | −0.35° | −0.33° | August | −0.25° | 0.50° |
| February | −0.60° | 0.00° | September | −0.15° | 0.00° |
| March | −0.50° | −0.67° | October | −0.22° | −0.60° |
| April | −0.75° | 0.50° | November | −0.28° | 0.00° |
| May | 0.05° | 0.00° | December | −0.25° | −0.33° |
| June | 0.30° | 0.28° | | | |
| July | 0.08° | 0.00° | Mean | −0.24° | −0.05° |

Column A (table 3) contains the average monthly temperature change between 5 a.m. and 6 a.m. Column B contains the average monthly temperature change between these hours when fog is present. Lack of sufficient cases is very likely responsible for the months under B which seem to be abnormal. However the means verify the generally accepted theory that temperature during fog tends to change relatively little. 5 a.m. to 6 a.m. was taken as the hour to be compared because of the "clustering" of fogs around 6 a.m. It is believed that the conditions which actually exist are represented by July. A for this month shows a rise of 0.08°, which is probably the result of "insolation"; while B for this month shows no change.

During the 2-hour period preceding fog the average velocity upon 2 occasions was 20 miles an hour.

Sixty-nine percent of the cases occurred with a wind velocity of 2–6 miles/hour; and 68 percent of the time in the 2-hour period preceding all fogs the wind velocity also was 2–6 miles/hour.

### HOURS OF OCCURRENCE

The mid-point of each of the 381 cases is shown on figure 5. It was found that more fogs are centered around 6 a.m. than any other hour, and that fogs to a very marked extent, tend to "cluster" around the hours 3 a.m.–6 a.m. It is significant that nearly ½ the cases fell within these limits. There is a very apparent increase for fog-centers between the hours 2 a.m. and 3 a.m., and an almost as noticeable drop in the cases of 6 a.m. and 7 a.m. Thus these data bring out very clearly that the above-mentioned hours are the ones in which fogs really tend to "cluster." This condition is very likely, at least to a large extent, owing to the fact that practically all radiational fogs are centered around these hours.

It is noted that there is an almost total absence of fogs between noon and 10 p.m. It was of course known that only relatively few fogs were centered around these hours, but the actual small number was somewhat unexpected. The vast majority of the fogs centered around these hours are unquestionably frontal, and occur almost entirely during the months in which this kind of fog predominates.

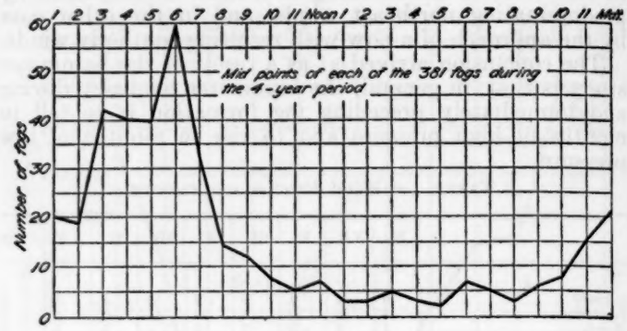
1 2 3 4 5 6 7 8 9 10 11 Noon 1 2 3 4 5 6 7 8 9 10 11 Mdt
60
50
40
30
20
10
0
Number of fogs
Mid points of each of the 381 fogs during the 4-year period

FIGURE 5.

## DUST STORM OF APRIL 12, 1934, BATON ROUGE, LA.

By RICHARD JOEL RUSSELL and R. DANA RUSSELL

[Louisiana State University]

Residents of the "Deep South" seldom experience visibility reduced to 3 or 4 (International Scale) as the result of atmospheric dust, hence speculation was rife on April 12, 1934, when this phenomenon occurred. Throughout the day in Baton Rouge, La., though the sky was cloudless, shadows were barely discernible. Sunshine duration, as recorded on a Friez instrument, was limited to 5 hours, 12 minutes, during the middle of the day, whereas a few days earlier in the season it had amounted to as much as 10 hours, 15 minutes. Notably reduced visibilities were reported at least as far east as Atlanta, Ga. An aviator flying at an elevation of 1,000 feet in central Louisiana found visibility so poor that he ascended to 6,000 feet to avoid dust and, later, had considerable difficulty in landing at Houston, Tex. Though the intensity of the dust storm was much greater in the Plains States, to the northwest, its occurrence was of unusual interest in the Southeast as having been possibly the severest on record.

*Weather conditions.*—Significant changes in weather conditions, as observed at Louisiana State University, for April 11, 12, and 13 are tabulated below.

| Time | Wind | | Relative | | | Notes |
|---|---|---|---|---|---|---|
| | Direction | Velocity | Temperature | Humidity | Pressure | |
| | | *Miles per hour* | *°F.* | *Percent* | *Inches* | |
| *Apr. 11* | | | | | | |
| 3:00 p.m. | SE. | 8 | 83.7 | >90 | 29.67 | |
| 4:15 p.m. | SW. | 4 | 81 | | | |
| 6:20 p.m. | S. | 6 | 77 | | | |
| 7:00 p.m. | SE. | 6 | 75.5 | 77 | 29.830 | |
| 8:13 p.m. | E. | 7 | 73 | | | |
| 8:47 p.m. | N. | 25 | 68 | | | 0.15 inch rain in 3 minutes; very severe electrical storm. |
| | *Veer* | | | | | |
| 9:04 p.m. | SW. | 3 | 69 | | | 0.04 inch rain in 15 minutes, to end. |
| 9:32 p.m. | W. | 3 | 69 | | | |
| 11:15 p.m. | N. | 5 | 69 | 67 | | |
| *Apr. 12* | | | | | | |
| 7:00 a.m. | N. | 11 | 57.0 | 43 | 29.970 | Dust storm lasting through day. |
| 2:00 p.m. | NW. | 10 | 68.4 | <40 | | |
| 7:00 p.m. | NW. | 5 | 60.5 | 46 | 29.900 | |
| *Apr. 13* | | | | | | |
| 7:00 a.m. | NW. | 4 | 48.8 | 72 | 29.930 | |

During the afternoon of April 11, Baton Rouge was covered by warm, moist, *southerly* air. Rather sultry conditions were ameliorated to some extent by increased wind velocity and a sharp shower accompanying a severe electrical storm later in the evening. The temperature, however, rose slightly after the storm and remained constant until almost midnight, when, with wind from the north, it dropped gradually to a minimum of 56° F. at 6 a.m., on the 12th. Hygrograph and thermograph curves were strikingly parallel during the night, both rising slightly between the cessation of rain and 11:15 p.m. The arrival of a *cold front* was accompanied by a long period of backing wind, a pronounced squall and thunder storm, and, finally, a long period of veering wind. The relative humidity remained decidedly low throughout April 12, when *polar* air conditions were thoroughly established.

Rain had fallen in Baton Rouge on 5 days of the week preceding April 11, with an accumulated total of 1.8 inches. On April 10 none fell but the soil remained comparatively moist from a fall of 0.48 inch on the 9th. It therefore seems evident that very little dust of local origin could have entered the air by the 12th. The showers during the evening of the 11th should have prevented any raising of dust by accompanying squall-winds. The sky was exceptionally clear soon after the electrical storm. At sunrise, somewhat more than 6 hours after northerly winds had become established, the entire sky was overcast by dust and horizontal visibilities on ground level were reduced to "Fair" or "Indifferent." Though there were no very striking differences in visibility during the day, it was the local consensus of opinion that they were most reduced in the late afternoon and were rapidly improving toward sunset. Prominent objects were unidentifiable at a distance of 1 mile when visibility was at a minimum.

*Description of dust.*—Dust was collected at a height of approximately 50 feet above the ground on a vertically suspended damp cloth about 1 yard square. At frequent intervals, between 2 and 4 p.m., the cloth was rinsed in water, which was subsequently filtered in order that the

residue could be subjected to petrographic examination by the junior author.

The material was found to be very fine, ranging in size of grains from colloidal dimensions up to almost 0.15 mm. The largest mineral grain was of muscovite mica and measured 0.085×0.04 mm. One quartz grain was almost as large, but most of the quartz was much smaller. About 50 percent of the material (by volume) was less than 0.005 mm in diameter, less than 5 percent over 0.025 mm, and the remainder between those dimensions. Many of the grains below 0.01 mm in diameter could not be determined with the equipment available. The substances recognized in the sample, therefore, were limited principally to the larger grains and were as follows:

*Approximate frequency (W) among grains larger than 0.01 mm in diameter*

| | |
|---|---|
| Volcanic glass | 56 |
| Quartz | 17 |
| Opaque grains, probably ashes and carbonaceous materials | 10 |
| Clay grains, mostly aggregates, in part weathered glass | 5 |
| Muscovite | 5 |
| Diatoms, several species, fresh-water types | 2 |
| Feldspars (undifferentiated) chiefly plagioclases | 1 |

*Less than 1 percent but fairly common*

Chlorite
Biotite
Microcline
Orthoclase
Hematite and limonite
Calcite, as aggregates and as cleavage fragments

*Rare*

Epidote, several grains
Zircon, 2 grains
Spherulites
Sponge spicules (?)
Titanite (?), one grain

The volcanic glass varies from colorless to brown, with a variety of shapes: irregular flat grains, curved fragments of bubble walls, grains including one or more bubbles, minute pumice fragments, and rod-shaped grains. Such shapes are typical of glass *shards*, blown from a volcano, and would hardly result from the weathering of glassy lavas. The largest grain of glass measured 0.14×0.098 mm. and a triple bubble 0.075×0.045 mm.

The highest percentage of volcanic glass does not necessarily mean that the dust came from an area where tuffs make up a large proportion of the surface outcrop. The relatively low specific gravity of the material and, especially, the shapes of the grains tend to concentrate glass fragments in finer dust, as heavier and more equidimensional grains settle out. Even a small percentage of volcanic glass in the soils from whence the dust originated would account for a high percentage of the material in dust drifted long distances.

The grains less than 0.005 mm in diameter apparently include less glass than the coarser sizes. Although the very finest material could not be definitely determined, it apparently consists largely of colloidal clay particles.

While the mineralogical analysis of the dust does not furnish a basis for the specific identification of the area of origin it strongly suggests, on the basis of rather uniformly very fine size and high percentage of volcanic glass, that the source was remote, and the direction of drift of the air mass which contained the dust points toward the Plains States as the source region.

## ANALYSIS OF THE PRECIPITATION OF RAINS AND SNOWS AT MOUNT VERNON, IOWA

By NICHOLAS KNIGHT

[Cornell College, Mount Vernon, Iowa, June 25, 1934]

In our work on the rains and snows for 1933–34, we treated 43 specimens of which 8 were snow and 35 were rain. The entire period was unusually dry. The precipitation for April was only one-eighth normal and some other months showed almost the same lack of moisture. The rain of May 9 was at the time of a heavy dust storm from the northwest and the bottom of the pans in which the water was collected for analysis was covered with a thick layer of black mud. There were a number of dust storms during the winter and spring. The rains of May and June, as a rule, were accompanied by severe thunder and lightning.

TABLE 1.—*Nitrogen and chlorine in rain and snow (parts per million)*

| Date | Precipitation in inches | | Chlorine | Free amm. | Alb. amm. | Nitrate | Nitrite | Sulphate $SO_3$ |
|---|---|---|---|---|---|---|---|---|
| | Rain | Snow | | | | | | |
| 1933 | | | | | | | | |
| June 22 | 0.5 | | 11.15 | 0.056 | 0.056 | | | |
| 23 | .45 | | 3.55 | .040 | .112 | | | |
| Sept. 24 | .25 | | 7.10 | .20 | .136 | | 0.001 | |
| 26 | 1.15 | | 7.10 | .32 | .112 | | .0014 | |
| Oct. 8 | .47 | | 7.10 | .272 | .16 | | .002 | |
| 10 | .2 | | 7.10 | | | | .0021 | |
| 15 | .25 | | 3.55 | .36 | .28 | | .012 | |
| 17 | .2 | | 7.10 | | | 0.2 | .0193 | |
| 21 | .2 | | 3.55 | .72 | .112 | .144 | .012 | |
| 26 | .42 | | 17.75 | | | .688 | .012 | 23 |
| Nov. 2 | .10 | | 3.55 | | | .176 | .155 | 15 |
| 5 | | 4 | 3.55 | .32 | .72 | .10 | .005 | 8 |
| 25 | | 1 | 17.75 | | | | | |

TABLE 1.—*Nitrogen and chlorine in rain and snow (parts per million)*—Continued

| Date | Precipitation in inches | | Chlorine | Free amm. | Alb. amm. | Nitrate | Nitrite | Sulphate $SO_3$ |
|---|---|---|---|---|---|---|---|---|
| | Rain | Snow | | | | | | |
| 1933 | | | | | | | | |
| Dec. 3 | 0.65 | | 2.13 | 0.02 | 0.28 | 0.06 | 0.0035 | 3.8 |
| 10 | | 2 | 3.55 | .28 | .16 | .078 | .005 | |
| 25 | | 4 | 1.42 | 1.12 | .056 | .062 | .0032 | 6 |
| 1934 | | | | | | | | |
| Jan. 4 | .5 | | .71 | .24 | .08 | .08 | .02 | 6.8 |
| 12 | .2 | | 3.55 | .32 | .045 | .18 | .014 | 7.6 |
| Feb. 16 | | 2 | 7.10 | .36 | .56 | | .0084 | |
| 18 | .4 | | 3.55 | .24 | .72 | | .0146 | 5 |
| 24 | | 3 | 11.15 | .72 | 1.2 | .12 | .006 | 14 |
| Mar. 2 | .2 | | .71 | .80 | .32 | .131 | .012 | 12 |
| 3 | .1 | | 3.55 | .05 | .85 | .13 | .0092 | 15 |
| 6 | .25 | | 1.42 | .04 | .72 | | .0092 | 10 |
| 9 | | 1 | 7.10 | | | .01 | .0071 | |
| 17 | .4 | | 3.55 | .40 | .36 | .192 | .19 | 10 |
| 23 | | 2 | 1.42 | .32 | .136 | .150 | .053 | |
| 30 | .1 | | 3.55 | | | .450 | .0258 | 50 |
| 30 | .2 | | 3.55 | | | .496 | .014 | 17 |
| Apr. 1 | .5 | | 3.55 | .16 | .36 | | .0121 | |
| 4 | .2 | | .71 | .48 | .16 | .12 | .01 | 28.5 |
| 26 | .12 | | 2.13 | | | .21 | .0017 | 10 |
| May 9 | .10 | | 10.65 | | | .3 | .02 | 10 |
| 13 | .6 | | 3.55 | .72 | .36 | .3 | .005 | |
| 21 | .12 | | 3.55 | 1.44 | 1.12 | .1 | .1 | 4.1 |
| 24 | .12 | | 3.55 | 1.80 | .64 | .01 | .02 | 0 |
| June 5 | .80 | | 10.65 | .36 | .32 | .20 | .025 | 0 |
| 6 | .50 | | 3.55 | .32 | .20 | .20 | .030 | 0 |
| 8 | 1.00 | | 3.55 | .08 | .36 | .20 | .035 | 0 |
| 9 | .15 | | 1.42 | .48 | .16 | .20 | .035 | 0 |
| 14 | .25 | | 2.13 | .42 | .136 | .2 | .38 | 0 |
| 17 | .08 | | .23 | | | .0018 | .004 | |
| 20, 22 | .65 | | 3.55 | .16 | .12 | .1 | .04 | 0 |

TABLE 2.—*Nitrogen and chlorine in rain and snow (pounds per acre)*

| Date | Precipitation in inches | | Chlorine | Free amm. | Alb. amm. | Nitrate | Nitrite | Sulphate $SO_3$ |
|---|---|---|---|---|---|---|---|---|
| | Rain | Snow | | | | | | |
| 1933 | | | | | | | | |
| June 22 | 0.5 | | 1.27 | 0.0064 | 0.0064 | | | |
| 25 | .45 | | .37 | .002 | .011 | | | |
| Sept. 24 | .25 | | .40 | .011 | .008 | | 0.00006 | |
| 26 | 1.15 | | 1.85 | .084 | .029 | | .00036 | |
| Oct. 8 | .47 | | .77 | .029 | .017 | | .0002 | |
| 10 | .2 | | .32 | | | | | |
| 15 | .25 | | .20 | .02 | .0159 | | .0007 | |
| 17 | .2 | | .32 | | | 0.009 | .0009 | |
| 21 | .2 | | .81 | .03 | .005 | .007 | .0001 | |
| 26 | .12 | | .48 | | | .02 | .0003 | 0.63 |
| Nov. 2 | .10 | | .08 | | | .004 | .00035 | .34 |
| 5 | | 4 | .27 | .025 | .055 | .008 | .00046 | .6 |
| 25 | | 1 | .34 | | | | | |
| Dec. 3 | .65 | | .32 | .003 | .04 | .023 | .0005 | .60 |
| 10 | | 2 | .136 | .011 | .006 | .003 | .00023 | |
| 25 | | 4 | .106 | .0084 | .004 | .0048 | .0025 | .45 |
| 1934 | | | | | | | | |
| Jan. 4 | .5 | | .081 | .027 | .009 | .009 | .002 | .77 |
| 12 | .2 | | .16 | .036 | .002 | .009 | .0007 | .21 |
| Feb. 16 | | 2 | .27 | .0134 | .0021 | | .00032 | |
| 18 | .4 | | .32 | .081 | .066 | | .0011 | .45 |
| 24 | | 3 | .64 | .055 | .068 | .007 | .0003 | .79 |

TABLE 2.—*Nitrogen and chlorine in rain and snow (pounds per acre)*—Continued

| Date | Precipitation in inches | | Chlorine | Free amm. | Alb. amm. | Nitrate | Nitrite | Sulphate $SO_3$ |
|---|---|---|---|---|---|---|---|---|
| | Rain | Snow | | | | | | |
| 1934 | | | | | | | | |
| Mar. 2 | 0.2 | | 0.032 | 0.036 | 0.014 | 0.0059 | 0.0006 | 0.54 |
| 3 | .1 | | .08 | .0011 | .019 | .0002 | .0002 | .34 |
| 6 | .25 | | .79 | .002 | .041 | | .0005 | .57 |
| 9 | | 1 | .013 | | | .00014 | .000136 | |
| 17 | .4 | | .32 | .036 | .032 | .0018 | .0017 | .91 |
| 23 | | 2 | .55 | .012 | .005 | .0057 | .0021 | |
| 30 | .1 | | .08 | | | .01 | .0006 | 1.14 |
| 30 | .2 | | .16 | | | .22 | .0006 | .76 |
| Apr. 1 | .5 | | .4 | .018 | .041 | | .0002 | |
| 4 | .2 | | .003 | .02 | .007 | .0055 | .0005 | 1.31 |
| 26 | .12 | | .058 | | | .006 | .0005 | .27 |
| May 9 | .10 | | .24 | | | .0068 | .0044 | .23 |
| 13 | .65 | | .15 | .05 | .025 | .045 | .0075 | |
| 21 | .12 | | .097 | .04 | .03 | .003 | .0004 | .11 |
| 24 | .12 | | .097 | .05 | .017 | .003 | .006 | |
| June 5 | .80 | | 1.92 | .065 | .058 | .036 | .0045 | 0 |
| 6 | .50 | | .40 | .036 | .023 | .023 | .0034 | 0 |
| 8 | 1.00 | | .8 | .02 | .08 | .04 | .08 | 0 |
| 9 | .15 | | .48 | .016 | .005 | .007 | .001 | 0 |
| 14 | .25 | | .121 | .024 | .008 | .01 | .002 | 0 |
| 17 | .08 | | .123 | | | .0018 | .004 | |
| 20, 22 | .65 | | .52 | .02 | .018 | .015 | .059 | 0 |

# CIRCULATION IN THE STRATOSPHERE OVER BRAZIL

By ADALBERTO B. SERRA

[Meteorological Institution of Brazil]

(Translated by A. R. Stickley)

The aerological observations in Brazil have rarely attained the height of 12 kilometers, in spite of the regularity with which they have been taken since 1921.

Only about a hundred soundings above this level have been effected over the whole country during the 12 years of operation of the Aerological Service. It is therefore impracticable to represent the results obtained by means of graphs or tables. Consequently, we shall only make a summary in the form of a simple commentary.

The level of 12 kilometers is in the stratosphere only over the southern part of the country. At the Equator, this height is within the troposphere, which there extends to about 15 kilometers above sea level. Thus the lower of the levels which we shall now discuss do not belong to the stratosphere in the equatorial zone. The layers to be studied are three: (*a*) from 12 to 15 kilometers; (*b*) from 15 to 20 kilometers; (*c*) above 20 kilometers. The periods are two: (*a*) winter (April to September, inclusive) and (*b*) summer (October to March, inclusive), corresponding respectively to the positions of the sun north and south of the equator. These data were furnished by the following stations: (*a*) in the Atlantic Ocean: Fernando Noronha; (*b*) along or near the coast: Quixeramobim, Olinda, Maceio, Sao Salvador, Victoria, Campos, Rio de Janeiro, Mendes, Sao Paulo dos Agudos, Curityba, and Porto Alegre; (*c*) in the interior of the continent: Cuyaba. We have arrived in this way at the following conclusions:

From 12 to 15 kilometers elevation the winds vary during summer from SE. to NW. through S. Along the coast there is a marked predominance from SE. to S. which appears to constitute the higher zone of the trade winds of the Southern Hemisphere. However, at Cuyaba, they come mainly from the W. to NW.

The winds are also the same during the winter, except at Fernando Noronha where they blow exclusively from the W. to NW. and at Cuyaba where, notwithstanding the reported currents from SE. to S, the most frequent are also those from the W. to NW.

From 15 to 20 kilometers, the winds blow from the SE. to NE. during the summer, except at Porto Alegre where they come from the south and at Cuyaba where they blow from SE. to W.

On the coastline, in winter, the circulation is from SE. to SW., except at Fernando Noronha, where there also are winds from the NW.

Beyond the 20-kilometer level, the circulation is exclusively from the ENE. to ESE., which seems, moreover, to be generally true for the whole region. The speeds vary in the two lower layers from 7 to 15 meters per second. However, not infrequently there are in this region light winds of from 1 to 2 meters per second and, very rarely, those of even greater speeds than 15 meters per second.

Beyond 20 kilometers there are winds of greater than 20 meters per second. The maximum to date is about 42 meters per second.

It is seen then that in the layers discussed, winds from the NW. to NE. sector rarely occur. Up to 20 kilometers, the circulation is generally from the south with easterly or westerly components—winds from the NE. to E. or from the NW. to W. being noted very rarely. The latter are, however, more frequent at Fernando Noronha and at Cuyaba. The circulation is always from the east beyond 20 kilometers.

These pilot-balloon observations are the only source of real information which exists concerning the circulation in the stratosphere over the Brazilian coast, and, despite their rarity, are preferable to hypotheses based only on surface observations.

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# SOLAR OBSERVATIONS

## SOLAR RADIATION MEASUREMENTS DURING MAY 1934

By IRVING F. HAND, *Assistant in Solar Radiation Investigations*

For a description of instruments employed and their exposures, the reader is referred to the January 1932 REVIEW, page 26.

Table 1 shows that solar radiation intensities averaged below normal for May at all three Weather Bureau stations.

Table 2, on the other hand, shows the greatest excess ever recorded for a whole month; every station being above normal with the exception of Miami, Fla. The large amount of radiation received during May, together with the low amount of precipitation in the Middle West, are two of the largest factors in producing the drought and unusually heavy dust storms of the month.

Table 3 shows large turbidity factors which explain in large part the minus departures of direct solar radiation. It was impossible to measure the amount of dust in the air by the red and yellow component method as our tables are not comprehensive enough.

Polarization measurements obtained on 7 days at Washington give a mean of 46 percent, with a maximum of 58 percent on the 7th. At Madison measurements made on 12 days give a mean of 52 percent with a maximum of 61 percent on the 22d. All these values are below the May normals. The reading of 11 percent obtained on the 11th at Washington is the lowest ever recorded by this Bureau at any station and is owing to one of the greatest dust storms ever noted in that city.

TABLE 1.—*Solar radiation intensities during May, 1934*

[Gram-calories per minute per square centimeter of normal surface]

**Washington, D.C.**

| Date | Sun's zenith distance | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8 a.m. | 78.7° | 75.7° | 70.7° | 60.0° | 0.0° | 60.0° | 70.7° | 75.7° | 78.7° | Noon |
| | 75th mer. time | Air mass | | | | | | | | | Local mean solar time |
| | | A.M. | | | | | P.M. | | | | |
| | e. | 5.0 | 4.0 | 3.0 | 2.0 | *1.0 | 2.0 | 3.0 | 4.0 | 5.0 | e. |
| | *mm* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *mm* |
| May 5 | 10.21 | | | | 0.74 | 1.14 | | | | | 5.56 |
| May 7 | 12.68 | | | | 1.04 | 1.32 | | | | | 11.38 |
| May 8 | 4.75 | | 0.75 | 0.94 | 1.07 | 1.38 | 1.13 | 0.84 | | | 5.16 |
| May 11 | 12.24 | | | | | .39 | | | | | 5.16 |
| May 12 | 4.95 | | | | .96 | | | | | | 4.57 |
| May 18 | 8.81 | 0.40 | .62 | .74 | .90 | 1.14 | | | | | 8.81 |
| May 21 | 12.24 | .62 | .70 | .84 | .99 | 1.22 | | | | | 12.24 |
| May 22 | 16.20 | | | | 1.08 | | | | | | 16.20 |
| May 23 | 7.57 | | | | | 1.40 | | | | | 5.36 |
| May 24 | 8.18 | | | .68 | 1.08 | 1.26 | | | | | 5.79 |
| May 28 | 6.02 | | | .82 | 1.04 | 1.26 | | | | | 5.79 |
| Means | | (.51) | .69 | .80 | .99 | 1.17 | (1.13) | (.84) | | | |
| Departures | | −.12 | −.02 | −.02 | +.00 | −.09 | +.22 | +.05 | | | |

TABLE 1.—*Solar radiation intensities during May, 1934*—Contd.

**Madison, Wis.**

| Date | Sun's zenith distance | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8 a.m. | 78.7° | 75.7° | 70.7° | 60.0° | 0.0° | 60.0° | 70.7° | 75.7° | 78.7° | Noon |
| | 75th mer. time | Air mass | | | | | | | | | Local mean solar time |
| | | A.M. | | | | | P.M. | | | | |
| | e. | 5.0 | 4.0 | 3.0 | 2.0 | [1] 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | e. |
| | *mm* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *mm* |
| May 2 | 8.81 | ------ | 0.66 | 0.81 | 1.00 | 1.21 | ------ | ------ | ------ | ------ | 7.87 |
| May 3 | 8.81 | ------ | ------ | ------ | 1.04 | 1.36 | ------ | ------ | ------ | ------ | 8.18 |
| May 4 | 7.87 | ------ | .63 | ------ | 1.01 | 1.53 | ------ | ------ | ------ | ------ | 10.97 |
| May 5 | 9.83 | ------ | ------ | ------ | 1.06 | 1.33 | ------ | ------ | ------ | ------ | 10.59 |
| May 7 | 6.76 | ------ | .52 | .64 | .88 | 1.38 | ------ | ------ | ------ | ------ | 5.56 |
| May 11 | 5.36 | ------ | ------ | ------ | .92 | 1.38 | ------ | ------ | ------ | ------ | 5.16 |
| May 14 | 6.50 | ------ | ------ | ------ | ------ | 1.46 | ------ | ------ | ------ | ------ | 6.76 |
| May 15 | 5.16 | ------ | .91 | 1.06 | 1.19 | 1.41 | ------ | ------ | ------ | ------ | 4.75 |
| May 16 | 4.37 | ------ | .73 | .84 | 1.01 | 1.51 | ------ | ------ | ------ | ------ | 5.16 |
| May 17 | 9.14 | ------ | ------ | ------ | ------ | 1.34 | ------ | ------ | ------ | ------ | 9.47 |
| May 18 | 7.87 | ------ | ------ | ------ | ------ | 1.28 | ------ | ------ | ------ | ------ | 10.59 |
| May 22 | 6.76 | ------ | .73 | .96 | 1.21 | 1.51 | ------ | ------ | ------ | ------ | 4.95 |
| May 23 | 5.79 | ------ | .80 | .95 | 1.12 | 1.44 | ------ | ------ | ------ | ------ | 5.36 |
| May 24 | 4.95 | 0.78 | .87 | .99 | 1.17 | 1.50 | ------ | ------ | ------ | ------ | 3.99 |
| May 25 | 3.99 | ------ | .82 | ------ | ------ | ------ | ------ | ------ | ------ | ------ | 4.17 |
| May 26 | 4.57 | ------ | .67 | .84 | .95 | 1.36 | ------ | ------ | ------ | ------ | 5.16 |
| May 29 | 7.57 | ------ | .59 | .74 | .94 | 1.30 | ------ | ------ | ------ | ------ | 10.21 |
| Means | ------ | (.78) | .72 | .87 | 1.04 | 1.39 | ------ | ------ | ------ | ------ | ------ |
| Departures | ------ | +.01 | −.07 | −.14 | −.06 | +.03 | ------ | ------ | ------ | ------ | ------ |

TABLE 1.—*Solar radiation intensities during May, 1934*—Contd.

**Lincoln, Nebr.**

| Date | Sun's zenith distance | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8 a.m. | 78.7° | 75.7° | 70.7° | 60.0° | 0.0° | 60.0° | 70.7° | 75.7° | 78.7° | Noon |
| | 75th mer. time | Air mass | | | | | | | | | Local mean solar time |
| | | A.M. | | | | | P.M. | | | | |
| | e. | 5.0 | 5.0 | 3.0 | 2.0 | [1] 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | e. |
| | *mm* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *mm* |
| May 6 | 10.21 | ------ | 0.90 | 1.01 | 1.20 | 1.37 | ------ | ------ | ------ | ------ | 9.14 |
| May 7 | 11.38 | ------ | .84 | 1.00 | 1.18 | 1.42 | 1.10 | 0.84 | ------ | ------ | 11.38 |
| May 8 | 12.24 | ------ | .87 | 1.01 | 1.11 | 1.43 | ------ | ------ | ------ | ------ | 10.59 |
| May 10 | 5.26 | ------ | .49 | .63 | .87 | 1.22 | .96 | .74 | 0.56 | 0.45 | 4.75 |
| May 15 | 4.19 | ------ | .67 | .85 | 1.06 | 1.38 | 1.04 | .82 | .68 | .54 | 3.99 |
| May 16 | 7.57 | ------ | .76 | .92 | 1.12 | 1.40 | 1.17 | .97 | .83 | .71 | 5.79 |
| May 17 | 8.18 | ------ | .74 | .91 | 1.15 | 1.38 | 1.15 | .94 | .79 | .68 | 7.87 |
| May 18 | 10.21 | ------ | .77 | .91 | 1.14 | 1.39 | 1.14 | .91 | .76 | .63 | 9.14 |
| May 19 | 9.83 | ------ | .74 | .89 | 1.11 | 1.33 | ------ | ------ | ------ | ------ | 9.14 |
| May 23 | 6.76 | ------ | ------ | .76 | .97 | 1.22 | ------ | ------ | ------ | ------ | 6.27 |
| May 25 | 4.57 | ------ | ------ | ------ | ------ | ------ | ------ | .96 | .81 | .67 | 4.17 |
| May 26 | 5.16 | ------ | ------ | ------ | ------ | ------ | 1.12 | .92 | .76 | .64 | 7.57 |
| May 28 | 6.27 | ------ | ------ | ------ | ------ | ------ | .98 | .77 | ------ | ------ | 9.47 |
| Means | ------ | ------ | .76 | .89 | 1.09 | 1.35 | 1.08 | .87 | .74 | .62 | ------ |
| Departures | ------ | ------ | −.02 | −.04 | −.03 | −.03 | −.02 | −.03 | −.07 | −.07 | ------ |

NOTE.—Blue Hill data not received in time for this issue. Will be published as a late report next month.

[1] Extrapolated.

TABLE 2.—*Average daily totals of solar radiation (direct+diffuse) received on a horizontal surface*

| Week beginning— | Washington | Madison | Lincoln | Chicago | New York | Fresno | Pittsburgh | Fairbanks | Twin Falls | La Jolla | Miami | New Orleans | Riverside | Blue Hill | Mount Washington |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gram-calories per square centimeter | | | | | | | | | | | | | | |
| 1934 | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* |
| Apr. 30 | 456 | 526 | 515 | 480 | 430 | 686 | 465 | 433 | 513 | 611 | 465 | 390 | 597 | 481 | ------ |
| May 7 | 588 | 418 | 535 | 413 | 546 | 695 | 467 | 433 | 587 | 600 | 441 | 256 | 587 | 584 | ------ |
| May 14 | 488 | 609 | 678 | 593 | 447 | 750 | 402 | 451 | 702 | 666 | 268 | 313 | 647 | 513 | ------ |
| May 21 | 488 | 580 | 663 | 628 | 474 | 612 | 426 | 366 | 589 | 623 | 436 | 419 | 574 | 525 | ------ |
| May 28 | 579 | 574 | 608 | 578 | 562 | 723 | 425 | 529 | 530 | 642 | 429 | 565 | 607 | 502 | ------ |
| | Departures from weekly normals | | | | | | | | | | | | | | |
| Apr. 30 | | | | | | | | | | | | | | | |
| May 7 | −2 | +79 | +37 | +94 | +36 | +81 | +88 | +53 | −15 | +181 | −50 | +39 | ------ | ------ | ------ |
| May 14 | +144 | −26 | +78 | +46 | +178 | +73 | +87 | +25 | +61 | +130 | −76 | −90 | ------ | ------ | ------ |
| May 21 | +21 | +131 | +140 | +181 | +52 | +102 | −14 | +11 | +80 | +202 | −236 | −41 | ------ | ------ | ------ |
| May 28 | −13 | +89 | +99 | +181 | +59 | −54 | −36 | −85 | −43 | +111 | −60 | +19 | ------ | ------ | ------ |
| | +60 | −77 | +88 | +125 | +125 | +38 | −53 | +93 | −82 | +165 | −75 | +97 | ------ | ------ | ------ |
| | Accumulated departures on June 3 | | | | | | | | | | | | | | |
| | −567 | +1,890 | +4,788 | +7,504 | +7,231 | +4,214 | −1,659 | −406 | +3,220 | +9,163 | −1,176 | +4,466 | ------ | ------ | ------ |

TABLE 3.—*Total, $I_m$, and screened, $I_v$, $I_r$, solar radiation intensity measurements, obtained during May 1934 and determinations of the atmospheric turbidity factor, $\beta$, and water-vapor content, $w$= depth in centimeters, if precipitated*

**American University, Washington, D.C.**

| Date and hour angle | Solar altitude | Air mass | $I_m$ | $I_v$ | $I_r$ | $\beta I_{m-r}$ | $\beta I_{v-r}$ | $\beta_{mean}$ | $\frac{I_w=0}{1.94}$ | $\frac{I_w=0-I_m}{1.94}$ | $w$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Percentage of solar constant | | |
| 1934 | | | | | | | | | | | |
| *May 7* | ° ′ | *m* | *gr. cal.* | *gr. cal.* | *gr. cal.* | | | | | | *mm* |
| 4:44 a.m. | 25 04 | 2.35 | 1.008 | 0.750 | 0.592 | 0.071 | 0.045 | 0.058 | 69.2 | 16.2 | 70 |
| 4:39 a.m. | 26 00 | 2.28 | 1.043 | .753 | .594 | .056 | .048 | .052 | 70.6 | 15.8 | 65 |
| 4:16 a.m. | 30 30 | 1.96 | 1.046 | .764 | .595 | .074 | .048 | .061 | 72.3 | 17.2 | 100 |
| 4:12 a.m. | 31 17 | 1.92 | 1.061 | .767 | .597 | .068 | .046 | .057 | 73.6 | 17.8 | 110 |
| 3:18 a.m. | 41 41 | 1.50 | 1.127 | .805 | .620 | .078 | .040 | .059 | 77.4 | 18.1 | 120 |
| 3:13 a.m. | 42 39 | 1.48 | 1.147 | .806 | .620 | .068 | .038 | .053 | 78.6 | 18.3 | 130 |
| 2:38 a.m. | 49 07 | 1.32 | 1.191 | .809 | .620 | .056 | .042 | .049 | 81.0 | 18.5 | 160 |
| 2:32 a.m. | 50 11 | 1.30 | 1.201 | .811 | .620 | .051 | .039 | .045 | 81.7 | 18.5 | 180 |
| *May 11* | | | | | | | | | | | |
| 0:16 a.m. | 68 39 | 1.07 | .288 | .198 | .159 | Impossible to compute; air so dusty.[1] | | | | | |
| 0:12 a.m. | 68 46 | 1.07 | .285 | .198 | .159 | Do. | | | | | |
| *May 12* | | | | | | | | | | | |
| 4:16 a.m. | 31 17 | 1.92 | .982 | .712 | .593 | .118 | .120 | .119 | 62.8 | 11.7 | 120 |
| 4:12 a.m. | 32 03 | 1.88 | .992 | .713 | .595 | .118 | .130 | .124 | 62.3 | 10.6 | 100 |
| *May 18* | | | | | | | | | | | |
| 4:59 a.m. | 23 47 | 2.48 | .782 | .615 | .501 | .090 | .108 | .099 | 59.2 | 18.2 | |
| 4:55 a.m. | 24 30 | 2.40 | .821 | .615 | .509 | .079 | .127 | .103 | 59.2 | 15.9 | |
| 4:52 a.m. | 25 06 | 2.37 | .827 | .616 | .512 | .078 | .180 | .129 | 55.0 | 11.4 | (2) |
| 3:19 a.m. | 43 07 | 1.46 | 1.027 | .717 | .517 | .035 | .023 | .029 | 82.5 | 28.5 | |
| 3:16 a.m. | 43 41 | 1.45 | 1.014 | .718 | .519 | .040 | .024 | .032 | 82.0 | 28.6 | 100 |

[1] See account of dust storm this same issue.
[2] Greater than 100.

Atmospheric conditions during turbidity measurements.
May 17, Temp. 22° C., wind, NW-18; Vis. 12 miles.
May 11. Temp. 20° C., wind, N-16; vis. 1 mile. Greatest amount of dust ever measured by this Bureau in Washington.
May 12. Tem. 19° C., wind, NW-13. Vis. 20 miles. Light dust in streaks. Clouds, p.m.
May 18. Temp. 25° C., wind, NW-12. Vis. 12 miles.

**Blue Hill Meteorological Observatory of Harvard University**

| Date and hour angle | Solar altitude | Air mass | $I_m$ | $I_v$ | $I_r$ | $\beta I_{m-r}$ | $\beta I_{v-r}$ | $\beta$mean | $I_w=0$ | $I_w=0-I_m$ | $w$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Percentage of solar constant | | |
| 1934 | | | | | | | | | | | |
| *May 1* | ° ′ | | *gr. cal.* | *gr. cal.* | *gr. cal.* | | | | | | *mm* |
| 2:44 a.m. | 45 33 | 1.40 | 1.341 | 0.929 | 0.765 | 0.068 | 0.080 | 0.074 | 76.2 | 6.5 | 2.7 |
| 1:43 p.m. | 54 55 | 1.22 | 1.328 | .914 | .724 | .063 | .073 | .068 | 79.4 | 9.9 | 10.1 |
| *May 5* | | | | | | | | | | | |
| 2:59 a.m. | 43 49 | 1.44 | 1.112 | .761 | .625 | .118 | .172 | .145 | 65.8 | 10.5 | 10.2 |
| 1:01 a.m. | 60 53 | 1.14 | 1.173 | .799 | .647 | .125 | .181 | .153 | 69.9 | 8.4 | 6.0 |
| *May 6* | | | | | | | | | | | |
| 2:59 a.m. | 44 43 | 1.42 | 1.373 | .908 | .733 | .037 | .090 | .064 | 78.6 | 6.5 | 2.6 |
| 3:19 p.m. | 40 30 | 1.54 | 1.270 | .902 | .705 | .054 | .035 | .044 | 79.7 | 13.1 | 31.0 |
| *May 8* | | | | | | | | | | | |
| 1:43 a.m. | 56 35 | 1.19 | 1.424 | .973 | .798 | .046 | .105 | .076 | 78.8 | 4.1 | 1.2 |
| 1:02 p.m. | 61 33 | 1.13 | 1.440 | 1.032 | .832 | .082 | .058 | .070 | 80.0 | 4.4 | 1.5 |
| 3:40 p.m. | 37 05 | 1.65 | 1.310 | .942 | .770 | .066 | .077 | .072 | 73.5 | 4.7 | 1.4 |
| *May 9* | | | | | | | | | | | |
| 3:56 a.m. | 34 20 | 1.77 | 1.239 | .869 | .701 | .054 | .075 | .064 | 73.7 | 8.6 | 4.5 |
| 1:56 a.m. | 55 55 | 1.20 | 1.263 | .870 | .714 | .100 | .160 | .130 | 68.9 | 2.6 | 1.0 |
| 0:57 p.m. | 63 26 | 1.12 | 1.328 | .913 | .739 | .061 | .107 | .084 | 78.6 | 8.9 | 8.0 |
| *May 11* | | | | | | | | | | | |
| 1:59 p.m. | 54 52 | 1.22 | .272 | .193 | .161 | | | | | | |
| *May 12* | | | | | | | | | | | |
| 3:43 a.m. | 37 15 | 1.65 | 1.185 | .856 | .711 | .101 | .127 | .114 | 67.0 | 4.7 | 1.4 |
| *May 13* | | | | | | | | | | | |
| 2:53 a.m. | 46 17 | 1.38 | 1.316 | .939 | .758 | .080 | .077 | .078 | 76.0 | 6.7 | 2.8 |
| 1:31 a.m. | 59 15 | 1.16 | 1.338 | .957 | .756 | .075 | .054 | .064 | 80.8 | 10.4 | 10.1 |
| *May 16* | | | | | | | | | | | |
| 4:30 p.m. | 29 06 | 2.06 | 1.228 | .909 | .747 | .068 | .067 | .068 | 69.7 | 5.0 | 1.5 |
| 5:33 p.m. | 17 33 | 3.30 | .893 | .705 | .583 | .084 | .071 | .078 | 56.7 | 9.6 | 4.3 |

TABLE 3.—*Total, $I_m$, and screened, $I_v$, $I_r$, solar radiation intensity measurements, obtained during May 1934 and determinations of the atmospheric turbidity factor, $\beta$, and water-vapor content, $w$= depth in centimeters, if precipitated*—Continued

**Blue Hill Meteorological Observatory of Harvard University**—Continued

| Date and hour angle | Solar altitude | Air mass | $I_m$ | $I_v$ | $I_r$ | $\beta I_{m-r}$ | $\beta I_{v-r}$ | $\beta$mean | $I_w=0$ | $I_w=0-I_m$ | $w$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Percentage of solar constant | | |
| 1934 | | | | | | | | | | | |
| *May 18* | ° ′ | | *gr. cal.* | *min.* | *cm*[3] | | | | | | |
| 3:29 a.m. | 40 30 | 1.50 | .992 | .720 | .594 | .170 | .190 | .180 | 60.4 | 8.1 | 4.1 |
| 2:04 a.m. | 55 10 | 1.22 | 1.166 | .823 | .667 | .133 | .151 | .142 | 70.0 | 3.4 | 0.9 |
| 1:35 p.m. | 59 41 | 1.16 | 1.249 | .906 | .718 | .121 | .078 | .100 | 76.0 | 10.4 | 16.0 |
| *May 19* | | | | | | | | | | | |
| 4:03 a.m. | 34 34 | 1.76 | 1.218 | .874 | .709 | .066 | .076 | .071 | 68.5 | 4.2 | 1.1 |
| 2:23 a.m. | 52 27 | 1.26 | 1.302 | .901 | .714 | .079 | .056 | .068 | 79.1 | 10.4 | 14.7 |
| 0:51 a.m. | 65 02 | 1.10 | 1.211 | .847 | .670 | .120 | .116 | .118 | 72.2 | 8.3 | 6.3 |
| 1:26 p.m. | 61 07 | 1.14 | 1.354 | .935 | .733 | .068 | .050 | .059 | 81.7 | 10.3 | 14.0 |
| *May 22* | | | | | | | | | | | |
| 1:51 a.m. | 58 02 | 1.18 | 1.213 | .838 | .670 | .162 | .179 | .170 | 78.1 | 14.0 | 49.0 |
| 0:51 a.m. | 65 36 | 1.09 | 1.232 | .838 | .661 | .100 | .114 | .107 | 76.3 | 11.1 | 23.0 |
| 1:57 p.m. | 57 01 | 1.19 | 1.262 | .879 | .683 | .075 | .056 | .066 | 80.5 | 13.9 | 48.0 |
| *May 23* | | | | | | | | | | | |
| 1:44 a.m. | 59 09 | 1.17 | 1.319 | .878 | .688 | .036 | .056 | .046 | 83.2 | 13.5 | 44.5 |
| *May 24* | | | | | | | | | | | |
| 3:54 a.m. | 36 52 | 1.66 | 1.257 | .873 | .714 | .058 | .050 | .054 | 76.5 | 10.0 | 9.3 |
| 3:22 a.m. | 43 02 | 1.46 | 1.312 | .894 | .720 | .046 | .081 | .064 | 77.1 | 7.7 | 3.8 |
| 1:31 a.m. | 61 15 | 1.14 | 1.326 | .923 | .726 | .066 | .056 | .061 | 81.9 | 11.8 | 28.0 |
| 0:40 a.m. | 61 42 | 1.13 | 1.254 | .880 | .697 | .100 | .081 | .090 | 77.6 | 11.3 | 24.0 |
| 3:31 p.m. | 41 05 | 1.52 | 1.188 | .828 | .673 | .091 | .118 | .104 | 70.3 | 7.5 | 3.4 |
| *May 27* | | | | | | | | | | | |
| 2:43 a.m. | 59 29 | 1.16 | 1.249 | .865 | .698 | .100 | .116 | .108 | 75.2 | 9.1 | 8.3 |
| 0:05 p.m. | 69 02 | 1.07 | 1.360 | .950 | .758 | .076 | .083 | .080 | 80.0 | 8.0 | 6.1 |
| 4:00 p.m. | 35 03 | 1.74 | 1.145 | .840 | .678 | .086 | .083 | .084 | 70.3 | 9.7 | 7.7 |
| *May 30* | | | | | | | | | | | |
| 0:39 a.m. | 67 55 | 1.08 | 1.142 | .826 | .658 | .170 | .100 | .135 | 73.2 | 12.7 | 40.0 |
| 5:06 p.m. | 24 11 | 2.43 | .626 | .513 | .394 | .187 | .108 | .148 | 50.7 | 17.6 | ----- |
| *May 31* | | | | | | | | | | | |
| 3:38 a.m. | 40 31 | 1.54 | .938 | .691 | .558 | .174 | .175 | .174 | 60.6 | 10.9 | 14.0 |
| 2:40 a.m. | 50 59 | 1.28 | 1.040 | .765 | .614 | .179 | .160 | .170 | 65.7 | 11.5 | 20.0 |
| 1:09 a.m. | 64 57 | 1.10 | 1.161 | .814 | .639 | .130 | .117 | .124 | 74.1 | 12.6 | 34.0 |
| 0:09 p.m. | 69 35 | 1.06 | 1.197 | .819 | .650 | .115 | .115 | .115 | 75.9 | 12.4 | 34.0 |

**Atmospheric Conditions During Solar Radiation Measurements**

| Date and hour angle from apparent noon | Air temperature | Wind | Visibility | Sky blueness | Clouds and remarks |
|---|---|---|---|---|---|
| *May 1934* | ° *C* | | | | |
| 1, 2:00 p. | 20.0 | SW. 4 | 7 | 6 | 3 ci; mod. haze. |
| 5, 2:45 a. | 16.7 | SW. 3 | 7 | 6 | 0 cld.; dense haze, fog clearing. |
| 6, 1:53 a. | 21.7 | W. 4 | 8 | 6 | 4 ci. and ci. cu. |
| 3:09 p. | 26.7 | W. 5 | 8 | 6 | 7 ci. and ci. cu.; wind gusty. |
| 8, 3:17 a. | 8.9 | WNW. 3 | 9 | 6 | Few ci. and cu.; ci film over sun. |
| 1:33 p. | 15.6 | NW. 4-5 | 8 | 6 | Few ci and cu. |
| 3:40 p. | 15.0 | NW. 4-5 | 9 | 6 | Few cist. and cu.; wind gusty. |
| 9, 3:13 a. | 10.0 | W. 2 | 8 | 4 | Few cist.; conditions good. |
| 11, 2:11 p. | 22.2 | SW. 6-7 | 4 | ------ | Dust storm, cu. and acu. seen faintly. |
| 12, 2:55 a. | 8.9 | NW. 3-4 | 5 | 4 | 2 cist., 2 cu. Possibly thin cist. over sun. |
| 13, 2:59 a. | 9.4 | NW. 2 | 9 | 6 | Cist. in the east, conditions excellent. |
| 16, 3:43 p. | 13.9 | NW. 4 | 9 | 8 | Ci. in east and west; ci. film near sun; gusty. |
| 18, 3:23 a. | 15.0 | NW. 2 | 7 | 4 | 0 clds. |
| 1:39 p. | 17.8 | NW. 6 | 7 | 4 | Few ci., few cu.; ci. film at end of obs. |
| 19, 2:21 a. | 13.3 | NW. 2 | 8 | 6 | Ci. low in west; conditions good. |
| 1:53 p. | 18.9 | W. 3 | 8 | 6 | Ci. or smoke film over sun. |
| 22, 0:39 a. | 25.6 | S. 6 | 7 | ------ | |
| 0:23 a. | 25.6 | S. 6 | 7 | 6 | Few ci. and acu.; wind gusty. |
| 23, 1:37 a. | 16.1 | NW. 2 | 7 | 6 | 1 cist., 1 cu. |
| 4:59 p. | 18.3 | WNW. 6 | 7 | 6 | 1 acu.; lt. haze, gusty. |
| 24, 3:19 a. | 13.3 | NW. 2 | 8 | 6 | 2 ci.; ci. film. |
| 3:11 p. | 20.0 | W. 4 | 8 | 4 | 4 cu. |
| 5:17 p. | 19.5 | W. 3 | 8 | 4 | 1 cist., 1 ast., 3 acu. |
| 27, 2:55 a. | 14.4 | NNE. 1 | 8 | 6 | 0 clds.; mod. haze, gusty. |
| 1:28 a. | 14.4 | NE. 3 | 8 | 6 | Few ci.; mod. haze, gusty. |
| 0:05 a. | 16.7 | ExN. 4 | 9 | 5 | 1 ci., few cu. |
| 2:01 p. | 17.2 | ExN. 1 | 9 | 3 | 2 ci.; lt. haze. |
| 3:57 p. | 17.8 | NE. 2 | 9 | 3 | 1 ci.; lt. haze. |
| 30, 0:25 a. | 23.9 | WNW. 1 | 8 | 5 | 1 cu., few st. cu.; mod. haze. |
| 31, 3:08 a. | 23.9 | SW. 4 | 7 | 5 | 2 acu.; thick haze. |
| 1:06 a. | 26.1 | W. 5 | 6 | ------ | Few cu.; thick haze. |
| 0:06 p. | 26.7 | W. 5 | 7 | ------ | 2 cu., 1 acu.; gusty. |
| 1:52 p. | 27.2 | WSW. 6 | 7 | ------ | 5 ci., 1 cu.; thick haze; sun obscured ci. |

## POSITIONS AND AREAS OF SUN-SPOTS

[Communicated by Capt. J. F. Hellweg, U.S. Navy, Superintendent U.S. Naval Observatory. Data furnished by the U. S. Naval Observatory in cooperation with Harvard and Mount Wilson Observatories. The difference in longitude is measured from the central meridian, positive west. The north latitude is positive. Areas are corrected for foreshortening and are expressed in millionths of the sun's visible hemisphere. The total area for each day includes spots and groups]

NOTE.—Owing to the fact that many reports were missing at the time of going to press, the complete May 1934 data will be published in the next (June) issue of the REVIEW.—Editor.

## PROVISIONAL SUN-SPOT RELATIVE NUMBERS FOR MAY 1934

(Dependent alone on observations at Zurich and its station at Arosa)

[Data furnished through the courtesy of Prof. W. Brunner, Eidgenössische Sternwarte, Zurich, Switzerland]

| May 1934 | Relative numbers | May 1934 | Relative numbers | May 1934 | Relative numbers |
|---|---|---|---|---|---|
| 1 | 7 | 11 | 10 | 21 | 29 |
| 2 | 0 | 12 | 7 | 22 | 34 |
| 3 | 0 | 13 | *d* 15 | 23 | *a* 33 |
| 4 | *Mc*– | 14 | 21 | 24 | 23 |
| 5 | 17 | 15 | 26 | 25 | 19 |
| 6 | *a* 21 | 16 | 25 | 26 | 17 |
| 7 | 26 | 17 | *d*– | 27 | 9 |
| 8 | 34 | 18 | 41 | 28 | 16 |
| 9 | 23 | 19 | 46 | 29 | 8 |
| 10 | 19 | 20 | *a* 37 | 30 | 0 |
| | | | | 31 | 0 |

Mean: 29 days—19.4.

*a*=Passage of an average-sized group through the central meridian.
*c*=New formation of a large center of activity: *E*, on the eastern part of the sun's disk; W, on the western part; *M*, in the central circle zone.
*d*=Entrance of a large or average-sized center of activity on the east limb.

# AEROLOGICAL OBSERVATIONS

[Aerological Division, D. M. Little, in charge]

By L. T. SAMUELS

Free-air temperatures during May averaged above normal at all stations listed in table 1 except Pensacola where negative departures occurred at all levels. Exceptionally large positive temperature departures occurred at the northern stations. Free-air relative humidities averaged mostly below normal.

Free-air resultant wind directions were more northerly than normal over most southern stations and were more southerly than normal over the extreme northwest (table 2). Elsewhere the resultant directions were generally close to normal. The resultant velocities were close to normal except at a number of southern stations where they were mostly below normal.

TABLE 1.—*Free-air temperatures and relative humidities obtained by airplanes during May 1934*

TEMPERATURE (°C.)

| Altitude (meters) m.s.l. | Boston, Mass.[1] (6 meters) | | Cleveland, Ohio[2] (246 meters) | | Dallas, Tex.[3] (146 meters) | | Norfolk, Va.[4] (3 meters) | | Omaha, Nebr.[5] (300 meters) | | Pembina, N.Dak.[6] (243 meters) | | Pensacola, Fla.[4] (2 meters) | | San Diego, Calif.[4] (5 meters) | | Washington, D.C.[4] (2 meters) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Departure from normal | Mean | Departure from normal | Mean | Departure from normal | Mean | Departure from normal | Mean | Departure from normal | Mean | Departure from normal | Mean | Departure from normal | Mean | Departure from normal | Mean | Departure from normal |
| Surface | 13.7 | (7) | 11.4 | (7) | 17.8 | (7) | 19.2 | +0.5 | 15.8 | (7) | 7.8 | (7) | 21.1 | −1.4 | 19.2 | +0.9 | 16.0 | −1.6 |
| 500 | 12.9 | (7) | 14.8 | (7) | 20.7 | (7) | 17.5 | −0.2 | 17.4 | (7) | 10.8 | (7) | 19.6 | −1.0 | 16.5 | +1.9 | 15.3 | −0.3 |
| 1,000 | 11.1 | +3.1 | 14.1 | +4.2 | 18.3 | +1.7 | 15.8 | 0.0 | 17.7 | +5.7 | 12.1 | +4.0 | 17.2 | −0.8 | 16.9 | +2.5 | 14.2 | +0.6 |
| 1,500 | 8.3 | +3.4 | 11.3 | +4.1 | 15.5 | +0.8 | | | 15.1 | +5.9 | 9.7 | +4.2 | | | | | | |
| 2,000 | 5.5 | +3.3 | 8.4 | +3.7 | 13.1 | +0.8 | 10.3 | +0.2 | 12.2 | +5.6 | 7.0 | +4.3 | 11.0 | −1.6 | 14.0 | +2.4 | 9.1 | +0.5 |
| 2,500 | 3.3 | +3.6 | 5.8 | +3.5 | 9.9 | +0.3 | | | 9.0 | +5.1 | 3.9 | +4.1 | | | | | | |
| 3,000 | 0.8 | +3.7 | 3.0 | +3.2 | 7.2 | +0.6 | 4.4 | +0.1 | 5.9 | +4.9 | 0.4 | +3.3 | 5.4 | −2.0 | 8.6 | +2.4 | 4.3 | +1.1 |
| 4,000 | −4.6 | | −2.3 | +3.6 | 1.6 | +1.2 | | | −1.7 | +3.1 | −6.1 | +2.8 | −0.8 | −2.2 | 2.2 | +2.3 | | |
| 5,000 | −11.2 | | −8.9 | +2.9 | −4.8 | +0.5 | | | −9.0 | +1.7 | −12.8 | +2.0 | −7.5 | −1.8 | | | | |

RELATIVE HUMIDITY (PERCENT)

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Surface | 69 | (7) | 73 | (7) | 85 | (7) | 77 | +6 | 63 | (7) | 73 | (7) | 88 | +7 | 68 | 0 | 70 | +4 |
| 500 | 60 | (7) | 58 | (7) | 67 | (7) | 70 | +8 | 60 | (7) | 61 | (7) | 83 | +7 | 73 | −2 | 61 | +1 |
| 1,000 | 55 | −16 | 51 | −13 | 68 | −1 | 62 | +6 | 53 | −9 | 51 | −9 | 80 | +11 | 58 | −3 | 54 | −2 |
| 1,500 | 55 | −20 | 48 | −14 | 66 | +8 | | | 52 | −10 | 49 | −11 | | | | | | |
| 2,000 | 58 | −18 | 48 | −10 | 61 | +12 | 59 | +6 | 50 | −10 | 49 | −10 | 77 | +20 | 36 | −2 | 52 | −3 |
| 2,500 | 57 | −14 | 47 | −5 | 62 | +17 | | | 49 | −9 | 50 | −8 | | | | | | |
| 3,000 | 56 | −9 | 48 | 0 | 56 | +11 | 54 | +3 | 48 | −10 | 52 | −5 | 70 | +24 | 30 | +2 | 48 | −3 |
| 4,000 | 50 | | 43 | −2 | 41 | −5 | | | 49 | −10 | 55 | +2 | 65 | +31 | 30 | +4 | | |
| 5,000 | 50 | | 41 | −3 | 30 | −23 | | | 48 | −14 | 55 | +4 | 61 | +31 | | | | |

Times of observations: Weather Bureau, 5 a.m.; Navy, 7 a.m.; and Massachusetts Institute of Technology, 8 a.m., E.S.T.

[1] Airplane observations made by M.I.T.; departures based on normals obtained from kite observations made at Blue Hill Meterological Observatory; Annals of the Astronomical Observatory of Harvard College (1904), vol. LVIII, pt. I, p. 59.
[2] Temperature departures based on normals determined by extrapolating latitudinally those of Royal Center, Ind., and Due West, S.C. Humidity departures based on normals of Royal Center, Ind.
[3] Temperature departures based on normals determined by interpolating latitudinally those of Groesbeck, Tex., and Broken Arrow, Okla. Humidity departures based on normals of Groesbeck, Tex.
[4] Naval air stations.
[5] Temperature and humidity departures based on normals of Drexel, Nebr.
[6] Temperature departures based on normals determined by extrapolating latitudinally those of Ellendale, N.Dak., and Drexel, Nebr. Humidity departures based on normals of Ellendale, N.Dak.
[7] Surface and 500-meter departures omitted because of difference in time of day between airplane observations and those of kites upon which the normals are based.

TABLE 2.—*Free-air resultant winds (meters per second) based on pilot balloon observations made near 7 a.m. (eastern standard time) during May 1934*

[Wind from N=360°, E=90°, etc.]

| Altitude (meters) m.s.l. | Albuquerque, N. Mex. (1,554 meters) | | Atlanta, Ga. (309 meters) | | Bismarck, N.Dak. (518 meters) | | Brownsville, Tex. (7 meters) | | Burlington, Vt. (132 meters) | | Cheyenne, Wyo. (1,873 meters) | | Chicago, Ill. (192 meters) | | Cleveland, Ohio (245 meters) | | Dallas, Tex. (154 meters) | | Havre, Mont. (762 meters) | | Jacksonville, Fla. (14 meters) | | Key West, Fla. (11 meters) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity |
| | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | |
| Surface | 6 | 1.0 | 10 | 1.4 | 31 | 0.8 | 143 | 0.5 | 191 | 1.5 | 285 | 3.9 | 245 | 1.0 | 185 | 0.7 | 114 | 1.5 | 254 | 1.4 | 297 | 0.4 | 182 | 1.7 |
| 500 | ------ | ------ | 46 | 3.2 | ------ | ------ | 165 | 3.8 | 252 | 3.1 | ------ | ------ | 236 | 4.5 | 253 | 2.0 | 160 | 4.3 | ------ | ------ | 232 | 1.8 | 160 | 3.0 |
| 1,000 | ------ | ------ | 68 | 2.5 | 303 | 0.6 | 154 | 1.7 | 289 | 5.0 | ------ | ------ | 262 | 5.2 | 291 | 4.5 | 162 | 2.7 | 257 | 4.3 | 244 | 2.6 | 190 | 3.2 |
| 1,500 | ------ | ------ | 51 | 2.0 | 306 | 3.9 | 39 | 1.4 | 287 | 6.3 | ------ | ------ | 274 | 6.1 | 292 | 5.4 | 156 | 1.6 | 268 | 6.6 | 212 | 1.7 | 199 | 2.5 |
| 2,000 | 222 | 0.7 | 8 | 1.6 | 292 | 4.7 | 356 | 2.1 | 293 | 7.8 | 275 | 6.2 | 296 | 5.0 | 289 | 6.1 | 75 | 0.6 | 263 | 7.2 | 224 | 2.5 | 214 | 3.2 |
| 2,500 | 244 | 1.6 | 338 | 1.2 | 280 | 6.0 | 345 | 3.5 | 289 | 8.2 | 277 | 5.8 | 295 | 5.4 | 287 | 6.9 | 41 | 2.2 | 259 | 7.5 | 238 | 3.1 | 225 | 4.7 |
| 3,000 | 270 | 2.9 | 326 | 1.3 | 287 | 8.2 | 336 | 3.6 | 291 | 9.7 | 279 | 4.6 | 301 | 5.8 | 296 | 7.0 | 29 | 4.3 | 261 | 7.7 | 249 | 4.1 | 235 | 4.2 |
| 4,000 | 276 | 4.1 | 272 | 1.7 | 291 | 11.3 | 309 | 4.3 | 278 | 8.5 | 280 | 4.7 | 306 | 6.0 | 305 | 7.4 | 42 | 6.7 | 269 | 10.3 | 253 | 2.8 | 260 | 5.1 |
| 5,000 | 276 | 3.0 | 338 | 4.7 | 296 | 9.5 | 321 | 3.9 | ------ | ------ | 278 | 4.6 | 1 | 7.2 | 4 | 7.3 | ------ | ------ | 264 | 12.4 | 294 | 3.6 | 276 | 6.5 |

| Altitude (meters) m.s.l. | Los Angeles, Calif. (217 meters) | | Medford, Oreg. (410 meters) | | Memphis, Tenn. (83 meters) | | New Orleans, La. (19 meters) | | Oakland, Calif. (8 meters) | | Oklahoma City, Okla. (402 meters) | | Omaha, Nebr. (306 meters) | | Phoenix, Ariz. (338 meters) | | Salt Lake City, Utah (1,294 meters) | | Sault Ste. Marie, Mich. (198 meters) | | Seattle, Wash. (14 meters) | | Washington, D.C. (10 meters) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity |
| | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | |
| Surface | 69 | 0.5 | 294 | 0.5 | 58 | 0.6 | 56 | 1.4 | 243 | 1.2 | 153 | 2.2 | 161 | 2.2 | 113 | 1.5 | 158 | 3.5 | 20 | 0.3 | 164 | 0.6 | 3 | 0.8 |
| 500 | 121 | 1.6 | 284 | 1.3 | 136 | 2.5 | 126 | 2.1 | 285 | 3.1 | 165 | 4.9 | 196 | 6.0 | 202 | 1.1 | ------ | ------ | 239 | 2.4 | 183 | 2.1 | 324 | 2.2 |
| 1,000 | 27 | .8 | 296 | 1.2 | 108 | 1.7 | 122 | 3.1 | 301 | 5.6 | 183 | 7.8 | 229 | 9.1 | 261 | 2.1 | ------ | ------ | 270 | 6.6 | 190 | 1.3 | 316 | 4.2 |
| 1,500 | 295 | 2.4 | 129 | .2 | 88 | .9 | 122 | 2.1 | 295 | 3.9 | 190 | 3.0 | 239 | 6.8 | 246 | 2.2 | 166 | 5.0 | 283 | 8.5 | 264 | 1.0 | 302 | 6.0 |
| 2,000 | 258 | 2.5 | 200 | 1.5 | 29 | 1.3 | 84 | 1.1 | 272 | 4.0 | 113 | .9 | 246 | 5.1 | 218 | 2.5 | 182 | 4.9 | 280 | 9.4 | 237 | 1.7 | 294 | 6.6 |
| 2,500 | 245 | 2.4 | 211 | 2.7 | 23 | 2.3 | 358 | 1.4 | 258 | 4.8 | 42 | 1.2 | 269 | 4.3 | 195 | 4.0 | 204 | 4.5 | 287 | 11.3 | 219 | 3.6 | 293 | 6.2 |
| 3,000 | 253 | 2.2 | 213 | 3.2 | 34 | 2.5 | 344 | 3.5 | 248 | 4.3 | 32 | 3.1 | 287 | 4.0 | 195 | 5.8 | 227 | 4.8 | 288 | 11.4 | 227 | 3.9 | 293 | 7.1 |
| 4,000 | 113 | .5 | 202 | 4.8 | 224 | .5 | 309 | 5.2 | 251 | 7.8 | 19 | 4.6 | 307 | 5.2 | 197 | 7.2 | 241 | 6.3 | 302 | 9.1 | 221 | 7.5 | 292 | 6.4 |
| 5,000 | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | 326 | 5.4 | 204 | 3.8 | 283 | 6.9 | 299 | 10.8 | 217 | 3.8 | ------ | ------ |

# RIVERS AND FLOODS

By RICHMOND T. ZOCH

[River and Flood Division, MONTROSE W. HAYES, in charge]

A moderate flood occurred in the Connecticut River in April, but little damage resulted since all were prepared for it, having been advised of the considerable depth of snow over the basin, and the consequent likelihood of a spring flood.

Minor floods occurred in some of the rivers of the Southeastern States and a slight one in the Neosho River in Kansas. No damage was caused by any of them.

Most rivers in the Mississippi system were exceptionally low for this month of the year.

Any noteworthy features that may be reported of the flood in the Columbia River will be mentioned in a later issue of the MONTHLY WEATHER REVIEW.

*Table of Flood Stages during May 1934*

[All dates are in May unless otherwise specified]

| River and station | Flood stage | Above flood stages—dates | | Crest | |
|---|---|---|---|---|---|
| | | From— | To— | Stage | Date |
| ATLANTIC SLOPE DRAINAGE | | | | | |
| | *Feet* | | | *Feet* | |
| Neuse: Neuse, N.C. | 13 | 18 | 18 | 14.4 | 18 |
| Saluda: Pelzer, S.C. | 7 | 16 | 16 | 7.0 | 16 |
| | | 3 | 6 | 12.8 | 5 |
| Santee: Rimini, S.C. | 12 | 17 | 21 | 14.5 | 20 |
| | | 23 | 27 | 13.4 | 26 |
| | | 30 | 31 | 13.2 | 31 |
| Savannah: Ellenton, S.C. | 14 | 2 | 5 | 15.4 | 4 |
| | | 18 | 21 | 16.8 | 20 |
| Ogeechee: Dover, Ga. | 7 | 9 | 10 | 7.0 | 9 |
| MISSISSIPPI SYSTEM | | | | | |
| *Arkansas Basin* | | | | | |
| Neosho: Le Roy, Kans. | 18 | 14 | 15 | 22.5 | 15 |
| PACIFIC SLOPE DRAINAGE | | | | | |
| *Columbia Basin* | | | | | |
| Columbia: | | | | | |
| Marcus, Wash. | 24 | Apr. 21 | (1) | (1) | (1) |
| Vancouver, Wash. | 15 | Apr. 29 | 25 | 17.1 | 9, 10 |
| | | 29 | (1) | (1) | (1) |

[1] Flood continued into June.

# WEATHER OF THE ATLANTIC AND PACIFIC OCEANS

[The Marine Division, W. F. McDONALD, in charge]

## NORTH ATLANTIC OCEAN

By H. C. HUNTER

*Atmospheric pressure.*—The northern and extreme western portions of the North Atlantic area, also the Gulf of Mexico, had average pressure below normal in May 1934, the departure being almost a quarter of an inch at Reykjavik, Iceland. The central and eastern North Atlantic had pressure moderately above normal.

The lowest pressure at any of the selected shore stations during the month was 28.98 inches at Reykjavik on the 8th. During the 2 days preceding this, however, a few readings slightly lower than 28.98 inches had been noted by vessels not far distant from the west coast of Ireland.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure (sea level) at selected stations for the North Atlantic Ocean and its shores, May 1934*

| Stations | Average pressure | Departure | Highest | Date | Lowest | Date |
|---|---|---|---|---|---|---|
| | *Inches* | *Inch* | *Inches* | | *Inches* | |
| Julianehaab, Greenland | 29.69 | | 30.24 | 23, 24 | 29.18 | 7 |
| Reykjavik, Iceland | 29.68 | −0.24 | 30.32 | 25 | 28.98 | 8 |
| Lerwick, Shetland Islands | 29.84 | +.04 | 30.42 | 11 | 29.10 | 17 |
| Valencia, Ireland | 30.09 | +.14 | 30.49 | 27 | 29.24 | 6 |
| Lisbon, Portugal | 30.04 | +.07 | 30.29 | 7 | 29.74 | 16 |
| Madeira | 30.04 | +.03 | 30.27 | 5 | 29.81 | 23 |
| Horta, Azores | 30.25 | +.09 | 30.46 | 9 | 29.94 | 24 |
| Belle Isle, Newfoundland | 29.88 | −.06 | 30.28 | 2 | 29.00 | 6 |
| Halifax, Nova Scotia | 29.99 | +.02 | 30.44 | 1 | 29.42 | 7 |
| Nantucket | 29.99 | .00 | 30.58 | 1 | 29.52 | 7 |
| Hatteras | 30.00 | −.01 | 30.39 | 1 | 29.63 | 29 |
| Bermuda | 30.13 | +.02 | 30.32 | 14 | 29.82 | 24, 25 |
| Turks Island | 29.99 | −.01 | 30.08 | 15 | 29.86 | 25, 26 |
| Key West | 29.93 | −.04 | 30.11 | 9 | 29.72 | 26 |
| New Orleans | 29.95 | −.02 | 30.20 | 1 | 29.75 | 30 |

NOTE.—All data based on a.m. observations only, with departures compiled from best available normals related to time of observation, except Hatteras, Key West, Nantucket, and New Orleans, which are 24-hour corrected means.

*Cyclones and gales.*—By the 4th a moderately well-developed storm was affecting the main steamship lanes near mid-ocean, and on the 6th and 7th this storm attained somewhat greater strength near Ireland. This storm soon drew to northward, however, and ceased to affect the chief steamship routes. The only instance yet known of a gale of force 11 in Atlantic waters this month was connected with this storm, the German steamship *Berlin* encountering winds of that force late on the 6th.

The next period when several vessels encountered gales occurred about the 18th, when a LOW from the Lake region united with a small LOW that originated at lower latitudes over the Atlantic, causing fresh to whole gales in regions south and east of Newfoundland on that day and the 19th.

A minor disturbance attained moderate strength near the south Atlantic coast of the United States about the 27th and a few steamers reported fresh to strong gales in that area. This storm had many characteristics of a tropical hurricane as it moved inland over South Carolina on May 29.

*Fog.*—Many parts of the North Atlantic had an increase of fog, compared with April, particularly areas to northward of the 40th parallel, between the 45th meridian and Europe. On the whole, there was even more fog than normally occurs during May along the chief routes to northern Europe, also near the American coast north of Cape Hatteras. The region of greatest frequency was the 5° square between 40° and 45° north, 45° and 50° west, where fog was reported on 21 days. The periods from the 8th to 10th and 19th to 23d had least fog in this vicinity.

As a rule, the region between the 50th and 65th meridians experienced somewhat less fog near the steamship lanes than is normal for May, but in areas from southwestern Nova Scotia to the vicinity of Hatteras, some 5° squares had 15 days with fog, which is more than normal for the month. Here fog was present frequently during the first 5 and the last 5 days of May, also from the 14th to the 23d, inclusive.

During the 3d and 4th the fog led to two collisions and one grounding near the north and middle Atlantic coasts, but fortunately none of these had serious results. On the forenoon of the 15th, however, the British liner *Olympic*, from Southampton to New York, ran into and sank the Nantucket Shoals lightship, with loss of 7 of the crew of 11 on the lightship.

*Dust at sea.*—On May 11, when at most places in the North and Middle Atlantic States fine dust was perceptible in the air, the British steamship *Boston City*, from Fowey for Boston, reported fine powder or dust noted about 6 p.m., the vessel then being about 140 miles east of the entrance to Boston Harbor.

*Transatlantic flights.*—There were two flights over the North Atlantic. Capt. George Pond and Lieut. Cesare Sabelli crossed from Floyd Bennett airfield to near Lahinch, Irish Free State, in about 32 hours, on the 14th and 15th. The conditions over the ocean on the 14th are presented in chart VIII.

Lieut. Maurice Rossi, with Paul Codos as companion, flew from Paris to New York in about 39 hours on the 26th to 28th. The weather situation of May 27 is shown by chart IX.

## OCEAN GALES AND STORMS, MAY 1934

| Vessel | Voyage | | Position at time of lowest barometer | | Gale began | Time of lowest barometer | Gale ended | Lowest barometer | Direction of wind when gale began | Direction and force of wind at time of lowest barometer | Direction of wind when gale ended | Direction and highest force of wind | Shifts of wind near time of lowest barometer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | From— | To— | Latitude | Longitude | | | | | | | | | |
| **NORTH ATLANTIC OCEAN** | | | ° ′ | ° ′ | | | | *Inches* | | | | | |
| Arizona, Dan. M.S. | Copenhagen | Bahia Blanca | 36 35 N. | 14 20 W. | May 1 | 8a, May 1 | May 1 | 29.86 | N | N, 8 | NE | N, 8 | |
| Lord Kelvin, Br. S.S. | Plymouth | Halifax | 51 28 N. | 36 10 W. | Apr. 30 | 4a, 2 | May 4 | 29.68 | W | WSW, 6 | WNW | W, 8 | WSW-WNW. |
| Boston City, Br. S.S. | Fowey | Boston | 48 10 N. | 32 06 W. | May 2 | Noon, 2 | May 3 | 29.98 | WSW | WSW, 8 | WNW | WSW, 8 | WSW-W. |
| El Isleo, Am. S.S. | New Orleans | New York | [1]35 02 N. | [1]75 19 W. | do | 1p, 3 | May 2 | 30.00 | NNE | WSW, 5 | NNW | N, 8 | W-SW. |
| Lord Kelvin, Br. S.S. | Plymouth | Halifax | 51 28 N. | 36 10 W. | May 5 | 10a, 5 | May 5 | 29.57 | NW | NW, 7 | NW | NW, 8 | W-NW. |
| Scanpenn, Am. S.S. | New York | Copenhagen | 55 45 N. | 23 40 W. | May 1 | Mdt, 3 | May 4 | 29.65 | WSW | W, 7 | W | —, 8 | None. |
| Syros, Am. S.S. | Houston | Havre | 46 23 N | 29 40 W. | May 5 | 4p, 5 | May 6 | 29.66 | NW | WNW, 4 | NW | NW, 9 | WNW-NW. |
| Emile Francqui, Belg. S.S. | Antwerp | New York | 49 25 N. | 15 37 W. | May 6 | 4a, 6 | do | 29.13 | WNW | WNW, 7 | W | W, 9 | SSW-S-W. |
| Tennessee, Dan. S.S. | New York | Oslo | 40 39 N. | 60 00 W. | May 7 | 8a 6 | May 8 | 29.85 | WSW | WSW, 6 | WSW | WSW, 10 | |
| Leto, Dutch S.S. | Port Talbot | Montreal | 51 24 N. | 11 10 W. | May 6 | 3p, 6 | May 6 | 29.02 | SW | SW, 10 | WNW | WSW, 10 | SW-W |
| Gorm, Dan. S.S. | Newcastle-on-Tyne | Portland, Maine. | 56 29 N. | 24 03 W. | May 7 | 4p, 6 | May 8 | 29.25 | SW | WNW, 7 | W | WSW, 10 | |
| Berlin, Ger. S.S. | Galway | New York | 52 50 N. | 12 00 W. | May 6 | 6p, 6 | May 7 | 28.90 | S | W, 9 | W | W, 11 | Steady. |
| Boston City, Br. S.S. | Fowey | Boston | 43 55 N. | 47 34 W. | do | 10p, 6 | May 6 | 29.64 | SW | SW, 8 | SW | SW, 8 | SW-W. |
| Sinaia, Fr. S.S. | Lisbon | Providence | 40 06 N. | 66 54 W. | do | 4p, 7 | May 7 | 29.65 | SSW | SW, 9 | SW | SW, 9 | SW-WSW. |
| Boston City, Br. S.S. | Fowey | Boston | 43 03 N. | 51 10 W. | May 7 | 1a, 8 | May 8 | 29.69 | SSW | SSW, 9 | NW | SSW, 9 | SSW-NW. |
| Tennessee, Dan. S.S. | New York | Oslo | 58 09 N. | 13 20 W. | May 15 | Noon, 15 | May 16 | 29.64 | NE | NE, 7 | NNW | NE, 9 | ENE-NE. |
| Toftwood, Br. S.S. | Fastnet | Montreal | 51 52 N. | 18 35 W. | May 18 | 11a, 18 | May 19 | 29.62 | SSE | SSE, 7 | SW | W, 8 | Steady. |
| Binnendijk, Du. S.S. | Rotterdam | Boston | 41 48 N. | 53 01 W. | do | 8p, 18 | May 18 | 29.36 | SSW | SSW, 8 | NW | SSW, 8 | SSW-NW. |
| Pres. Van Buren, Am. S.S | Gibraltar | New York | 39 40 N. | 54 39 W. | do | 9p, 18 | do | 29.69 | SW | WSW, 10 | NW | SW, 10 | SW-W. |
| Gripsholm, Swed. M.S. | Gothenburg | do | 42 57 N. | 50 52 W. | do | 10p, 18 | May 19 | 29.53 | SW | SW, 9 | W | W, 10 | |
| Frederik VIII, Dan. S.S. | Oslo | do | 43 00 N. | 51 00 W. | do | Mdt, 18 | do | 29.34 | S | S, 8 | S | S, 8 | S-SW-W. |
| Executive, Am. S.S. | Gibraltar | do | 37 00 N. | 59 00 W. | do | 1a, 19 | May 18 | 29.92 | SW | W, 6 | SW | SW, 8 | SW-W-NW. |
| Sundance, Am. S.S. | Rotterdam | Jacksonville | 46 24 N. | 35 48 W. | May 19 | 4p, 19 | May 19 | 29.64 | SW | SW, 8 | SW | SW, 8 | None. |
| Daghild, Nor. M.S. | Port de Bouc | Houston | 35 58 N. | 6 56 W. | May 22 | 4p, 22 | May 22 | 30.01 | E | E, 8 | E | E, 8 | Steady. |
| Berlin, Ger. S.S. | New York | Galway | 44 20 N. | 44 36 W. | do | 4a, 23 | May 23 | 29.51 | N | NNW, 10 | N | NW, 10 | NW-NNW-N. |
| Toftwood, Br. S.S. | Fastnet | Montreal | 50 10 N. | 38 10 W. | May 23 | 10a, 23 | do | 29.98 | ENE | NE, 6 | NE | ENE, 8 | Steady. |
| West Harshaw, Am. S.S. | New Orleans | Liverpool | 38 26 N. | 63 05 W. | May 24 | Noon, 24 | May 24 | [2]29.76 | SSW | S, 7 | S | S, 9 | SSW-S-SSW. |
| Resolute, Ger. S.S. | Habana | New York | 30 30 N. | 77 54 W. | May 27 | 7a, 27 | May 27 | 29.73 | NNE | NNE, 8 | N | NE, 8 | |
| Gulflight, Am. S.S. | Port Arthur | Wilmington, N.C | 31 04 N. | 79 44 W. | May 28 | 4p, 28 | May 28 | 29 26 | WSW | WSW, 8 | SW | SW, 9 | SSW-WSW-SW |
| Cities Service Kansas, Am. S.S. | Boston | Port Arthur | 33 50 N. | 75 31 W. | do | 3a, 29 | May 30 | 29.73 | E | S, 8 | SSW | S, 8 | E-S-SSW. |
| **NORTH PACIFIC OCEAN** | | | | | | | | | | | | | |
| Pres. Jackson, Am. S.S. | Victoria | Yokohama | 52 43 N. | 153 45 W. | Apr. 30 | 6p, May 1 | May 1 | 29.01 | SE | SW, 8 | SW | SE, 8 | SW-W. |
| Saparoea, Du. M.S. | Manila | San Francisco | 43 54 N. | 163 18 E. | May 1 | 1a, 2 | May 2 | 29.20 | E | NE, 9 | NNW | N, 10 | ENE-NNW. |
| New Westminster City, Br. S.S. | P.I. | Los Angeles | 39 16 N. | 169 40 W. | do | 3a, 2 | do | [2]29.42 | SSE | WSW, 9 | W | SW, 9 | SW-W. |
| Golden Dragon, Am. S.S. | San Francisco | Osaka | 45 17 N. | 173 07 E. | do | 11a, 2 | do | 28.87 | W | NNE, 6 | WNW | NNW, 9 | SW-NNE. |
| Pres. Jackson, Am. S.S. | Victoria | Yokohama | 52 48 N. | 160 26 W. | May 3 | 2p, 2 | May 3 | 28.86 | NW | E, 5 | NNW | NNW, 9 | S-E-NE. |
| Nippon Maru, Jap. S.S. | Yokohama | San Francisco | 41 45 N. | 179 16 W. | May 2 | 4p, 2 | May 2 | 29.29 | SW | SSW, 7 | SW | SW, 8 | S-SSW-SW. |
| Ogura Maru, Jap. M.S. | Estero Bay, Calif. | Yokohama | 39 56 N. | 159 02 W. | do | do | May 3 | 29.40 | WSW | WSW, 8 | W | W, 8 | SW-W. |
| Fernbrook, Nor. M.S. | P.I. | Los Angeles | 42 15 N. | 152 28 W. | do | 2a, 3 | May 5 | 29.29 | W | W, 10 | WSW | W, 10 | S-W. |
| San Pedro, Am. S.S. | do | do | 39 00 N. | 149 55 W. | do | 3a, 3 | May 4 | 29.54 | SSW | W, 8 | W | W, 9 | SW-W. |
| City of Vancouver, Br. S.S. | Seattle | Yokohama | [1]51 01 N. | [1]134 48 W. | May 3 | 6a, 4 | do | 28.77 | SE | S, 5 | S | SE, 8 | |
| Fernhill, Nor. M.S. | Manila | Los Angeles | 42 16 N. | 173 00 E. | May 5 | 8p, 5 | May 5 | 29.99 | NE | NE, 7 | NE | NE, 8 | E-NE. |
| San Julian, Am. S.S. | Portland, Oreg. | Pukow | 48 00 N. | 163 48 E. | May 7 | 4a, 8 | May 8 | 29.75 | S | SW, 7 | SW | SSW, 8 | SSW-WSW. |
| Yeiyo Maru, Jap. S.S. | Estero Bay, Calif. | Yokohama | 42 43 N. | 138 20 W. | May 8 | Mdt. 8 | May 9 | 29.83 | SSW | SW, 8 | SW | SW, 8 | SSW-SW. |
| Toba Maru, Jap. S.S. | Yokohama | San Francisco | 47 45 N. | 169 20 W. | May 9 | 4a, 9 | do | 29.57 | SSE | S, 8 | W | S, 8 | |
| Fernhill, Nor. M.S. | Manila | Los Angeles | 44 05 N. | 162 48 W. | do | 4p, 9 | do | 29.84 | S | S, 9 | SSW | SSW, 9 | S-SSW. |
| Resolute, Ger. S.S. | Hilo | San Francisco | 37 45 N. | 122 42 W. | May 11 | 4a, 12 | May 11 | 29.80 | NNE | NNW, 3 | N | N, 8 | N-NNW. |
| San Julian, Am. S.S. | Portland, Oreg. | Pukow | 40 00 N. | 137 48 E. | May 14 | 2a, 14 | May 14 | 29.44 | WNW | NW, 7 | WNW | WNW, 8 | None. |
| Golden Tide, Am. S.S. | Manila | San Francisco | 39 00 N. | 153 00 E. | do | 3a, 15 | May 15 | 29.59 | SSE | S, 8 | S | SSE, 9 | SSE-S. |
| San Clemente, Am. S.S. | Balboa | San Diego | 15 48 N. | 94 42 W. | May 28 | 4p, 28 | May 28 | 29.88 | NW | NW, 6 | NE | NNE, 10 | NW-N. |

[1] Position approximate.

[2] Barometer uncorrected.

## NORTH PACIFIC OCEAN MAY 1934

By WILLIS E. HURD

*Atmospheric pressure.*—Throughout the Alaskan region, from the Arctic Ocean to the Aleutian Islands and eastward to Juneau, atmospheric pressure was below the normal for May, with the greatest departure, −0.20 inch, at Point Barrow. Elsewhere practically normal barometric conditions prevailed, except for small excesses in pressure over the Nansei and Ogasawara Islands.

Early in the month near-winter depths of the Aleutian LOW were established, with minima of 28.7 to 28.9 inches recorded on the 3d over a considerable oceanic area between the Peninsula of Alaska and British Columbia.

The North Pacific anticyclone overlay central and eastern waters of the ocean in middle latitudes.

In the Far East disturbed pressure conditions were frequent, but no LOWS of maritime consequence appear to have developed in the tropics.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level, North Pacific Ocean, May 1934 at selected stations*

| Stations | Average pressure | Departure from normal | Highest | Date | Lowest | Date |
|---|---|---|---|---|---|---|
| | *Inches* | *Inch* | *Inches* | | *Inches* | |
| Point Barrow | 29.89 | −0.20 | 30.34 | 23 | 29.50 | 6 |
| Dutch Harbor | 29.81 | −.03 | 30.32 | 21 | 29.10 | 2 |
| St. Paul | 29.82 | −.02 | 30.44 | 21 | 29.06 | 10 |
| Kodiak | 29.78 | −.06 | 30.30 | 20 | 29.02 | 1 |
| Juneau | 29.92 | −.07 | 30.38 | 21 | 28.98 | 4 |
| Tatoosh Island | 30.02 | +.01 | 30.46 | 20 | 29.40 | 4 |
| San Francisco | 29.98 | −.01 | 30.22 | 8 | 29.75 | 21 |
| Mazatlan | 29.86 | +.01 | 29.94 | 10 | 29.74 | 31 |
| Honolulu | 30.05 | .00 | 30.16 | 15 | 29.93 | 31 |
| Midway Island | 30.07 | +.02 | 30.32 | 6 | 29.84 | 23 |
| Guam | 29.89 | +.01 | 29.98 | 31 | 29.74 | 21 |
| Manila | 29.79 | −.06 | 29.88 | 6 | 29.70 | 23 |
| Naha | 29.88 | +.06 | 30.16 | 1 | 29.60 | 27 |
| Chichishima | 29.96 | +.05 | 30.18 | 7 | 29.74 | 26 |
| Nemuro | 29.92 | ---------- | 30.22 | 30 | 29.26 | 14 |

NOTE.—Data based on 1 daily observation only, except those for Juneau, Tatoosh Island, San Francisco, and Honolulu which are based on 2 observations. Departures are computed from best available normals related to time of observation.

*Cyclones and gales.*—On the 1st to 3d cyclonic activity was widespread over northern and higher central waters, with the greatest depths noted on the 3d in 48°–55°N., 130°–145°W. The result was scattered gales, principally on the 2d and 3d, which were experienced along the northern routes between 160°E. and 130°W. These higher velocities were mostly of fresh to strong force (8–9), but in two instances rose to a whole gale (force 10), one near 44°N., 163°E., on the 2d; the other near 42°N., 152°W. on the 3d.

A second cyclone of some depth lay over the central Aleutians on the 9th–12th. On the 9th a southeast gale of force 10 occurred at Dutch Harbor, and gales of less force on the 9th were exeprienced by steamers as far south as the 40th parallel.

The third rather deep cyclone of the month occurred on the 14th over the northern part of the Japan Sea and on the 15th to the eastward of Hokoshu Island, and caused fresh to strong gales in waters west and east of northern Japan.

On the 11th a fresh northerly gale was experienced not far outside of San Francisco Harbor.

Subsequently to the 15th only three observations of winds of gale force are noted on our Pacific weather maps for May. One was of force 8, on the 21st, in 50°N., 150°W., and the other two were of force 8 and 10, on the 28th, apparently of norther type, in the Gulf of Tehuantepec.

*Fog.*—Fog was observed in middle and higher latitudes from coast to coast. The regions of greatest frequency lay off the California coast, with 8 days of occurrence observed; off the coast of Lower California, 7 days, and over a considerable region east of Japan and the Kuril Islands, with 3 to 5 or more days in each 5° square. Between 40°–50°N., 140°–160°W., 2 to 4 or more days with fog occurred in each included 5° square. Off the Mexican coast near Manzanillo stress was laid by observers upon the extraordinary appearance of fog on the 2d. to 4th.

## CLIMATOLOGICAL TABLES

### CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

*Condensed climatological summary of temperature and precipitation by sections, May 1934*

[For description of tables and charts, see REVIEW, January, p. 31]

| Section | Temperature | | | | | | | | Precipitation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Section average | Departure from the normal | Monthly extremes | | | | | | Section average | Departure from the normal | Greatest monthly | | Least monthly | |
| | | | Station | Highest | Date | Station | Lowest | Date | | | Station | Amount | Station | Amount |
| | ° F. | ° F. | | ° F. | | | ° F. | | In. | In. | | In. | | In. |
| Alabama | 72.2 | +0.9 | Riverton | 97 | [1] 11 | Riverton | 40 | 25 | 3.91 | −0.01 | Evergreen | 9.63 | Valley Head | 0.12 |
| Arizona | 72.3 | +3.3 | 2 stations | 115 | [1] 10 | Grand Canyon | 22 | 3 | .54 | +.25 | Williams | 2.96 | 13 stations | .00 |
| Arkansas | 70.3 | +1.2 | 3 stations | 103 | 31 | Dutton | 35 | [1] 27 | 3.36 | −1.63 | Norman | 5.72 | Corning | 1.12 |
| California | 63.8 | +2.5 | Blythe | 115 | 11 | Ellery Lake | 14 | 2 | .73 | −.27 | Scotia | 3.36 | 51 stations | .00 |
| Colorado | 59.6 | +7.4 | Eads | 106 | 30 | Lake Moraine | 12 | 14 | 1.35 | −.52 | Silver Lake | 3.87 | 2 stations | .08 |
| Florida | 75.7 | +.1 | 6 stations | 95 | [1] 23 | 3 stations | 52 | 29 | 6.81 | +2.76 | Homestead | 20.94 | Clearwater | 1.96 |
| Georgia | 70.9 | −.8 | Eastman | 96 | 23 | Blairsville | 36 | 3 | 5.45 | +1.98 | Tifton | 12.42 | Rome | 2.28 |
| Idaho | 59.6 | +6.7 | Orofino | 105 | 24 | Big Springs | 14 | [1] 11 | .61 | −1.03 | Prichard | 2.72 | 2 stations | T |
| Illinois | 68.1 | +5.6 | 2 stations | 107 | 31 | Waukegan | 28 | 26 | 1.06 | −3.03 | Benton | 3.57 | Carlinville | .13 |
| Indiana | 66.4 | +4.2 | Collegeville | 103 | 31 | La Porte | 28 | 12 | 1.14 | −2.86 | Jeffersonville | 3.29 | Veedersburg | .20 |
| Iowa | 69.6 | +9.6 | Inwood | 111 | 30 | 2 stations | 30 | 25 | 1.02 | −3.06 | Lamoni | 3.42 | Lake Park | .09 |
| Kansas | 69.6 | +5.8 | 2 stations | 106 | 30 | do | 35 | [1] 14 | 2.82 | −.87 | Burlington | 7.88 | Richfield | .10 |
| Kentucky | 67.7 | +2.4 | do | 99 | 31 | Farmers | 36 | 26 | 1.67 | −2.29 | Murray | 5.23 | Ford | .51 |
| Louisiana | 73.3 | −.4 | Ruston | 102 | 31 | St. Joseph | 44 | 1 | 5.38 | +.84 | Delta Farms | 15.31 | Arcadia | 1.22 |
| Maryland-Delaware | 64.0 | +1.6 | Keedysville, Md | 97 | 21 | Oakland, Md | 28 | 12 | 4.85 | +1.44 | Salisbury, Md | 9.12 | Cumberland, Md | 1.50 |
| Michigan | 58.3 | +4.5 | 5 stations | 100 | 31 | Vanderbilt | 14 | 12 | 1.23 | −1.97 | Fenville | 2.68 | Bay City | T |
| Minnesota | 63.7 | +8.6 | Maple Plain | 112 | 31 | Hallock | 18 | 11 | .99 | −2.20 | Mizpah | 2.82 | Maple Plain | .13 |
| Mississippi | 72.4 | +.7 | Greenwood | 102 | 31 | 2 stations | 44 | 26 | 3.64 | −.76 | Woodville | 10.80 | Grenada | 1.28 |
| Missouri | 69.0 | +4.6 | Maryville | 110 | 30 | Elsberry | 31 | 25 | 1.89 | −2.84 | Caruthersville | 4.64 | St. Charles | .22 |
| Montana | 59.9 | +8.3 | 3 stations | 104 | 29 | Conways Ranch | 15 | 13 | .67 | −1.55 | Heron | 2.03 | Melstone | .01 |
| Nebraska | 69.4 | +10.4 | Wakefield | 109 | 27 | Gordon | 26 | 14 | 1.06 | −2.47 | Auburn | 3.65 | Cairo | T |
| Nevada | 62.5 | +7.1 | Logandale | 110 | 11 | Zorra Vista Ranch | 18 | 2 | .37 | −.51 | Marlette Lake | 1.43 | 8 stations | .00 |
| New England | 57.0 | +2.0 | Turner's Falls, Mass | 92 | 31 | Van Buren, Me | 20 | 9 | 2.94 | −.42 | Waterbury, Conn | 6.56 | 2 stations | .93 |
| New Jersey | 62.3 | +1.9 | Camden | 98 | 21 | 3 stations | 28 | 13 | 4.63 | +.90 | Little Falls | 6.51 | Burlington | 2.88 |
| New Mexico | 64.4 | +4.8 | 2 stations | 108 | [1] 6 | Therma | 19 | 15 | 1.16 | +.03 | Portales | 4.86 | 6 stations | .00 |
| New York | 58.3 | +2.4 | Glenham | 95 | 21 | Indian Lake | 19 | 13 | 2.16 | −1.34 | Bedford Hills | 7.53 | Dansville | .24 |
| North Carolina | 66.4 | −.4 | High Point | 97 | 7 | Mount Mitchell | 32 | [1] 26 | 4.54 | +.35 | Swansboro | 12.62 | Boone | 1.94 |
| North Dakota | 63.6 | +10.8 | Langdon | 111 | 30 | Edmore | 18 | 11 | .35 | −2.05 | Napoleon | 1.36 | Zap | .00 |
| Ohio | 64.1 | +3.6 | Van Wert | 100 | 31 | Holgate | 27 | 12 | .79 | −2.87 | Peebles (near) | 1.97 | Charlestown | .29 |
| Oklahoma | 70.4 | +2.2 | Jefferson | 107 | 31 | Hooker | 32 | 15 | 2.62 | −2.05 | Apache | 6.32 | Hugo | .25 |
| Oregon | 57.9 | +4.8 | Arlington | 103 | 28 | Fremont | 16 | 9 | .89 | −.88 | Tillamook | 5.47 | Kingman | T |
| Pennsylvania | 62.2 | +2.8 | 3 stations | 98 | [1] 21 | Gouldsboro | 22 | 2 | 2.51 | −1.39 | Marcus Hook | 6.80 | McKeesport | .37 |
| South Carolina | 69.0 | −1.9 | Cheraw | 96 | 7 | 2 stations | 40 | [1] 1 | 5.58 | +1.96 | Yemassee | 10.01 | Pinopolis | 1.57 |
| South Dakota | 69.3 | +12.8 | 2 stations | 113 | 30 | 3 stations | 23 | 13 | .69 | −2.30 | Fairfax | 4.11 | McLaughlin | T |
| Tennessee | 68.7 | +.9 | Halls | 99 | 30 | do | 38 | [1] 26 | 2.81 | −1.38 | Gatlinburg | 6.72 | Selmer | .93 |
| Texas | 74.5 | +1.4 | Haskel | 108 | 29 | Muleshoe | 34 | 15 | 1.88 | −1.83 | Clarendon | 8.30 | 4 stations | .00 |
| Utah | 62.8 | +7.5 | St. George | 100 | [1] 10 | Heber | 19 | 2 | .37 | −.83 | Bryce Canyon | 2.76 | 5 stations | .00 |
| Virginia | 65.3 | +1.2 | 3 stations | 98 | 20 | Burkes Garden | 28 | 26 | 4.11 | +.31 | Williamsburg | 11.34 | Pennington Gap | .87 |
| Washington | 57.8 | +3.0 | 4 stations | 103 | 28 | Stockdill Ranch | 23 | 9 | 1.97 | −.05 | Mount Baker Lodge | 10.13 | White Swan | .00 |
| West Virginia | 63.1 | +1.4 | 2 stations | 100 | [1] 20 | Bayard | 27 | 26 | 2.08 | −1.89 | Pickens | 4.41 | Cairo | .92 |
| Wisconsin | 62.4 | +7.2 | Prairie du Chien | 109 | 31 | P. K. Reservoir | 20 | 25 | 1.47 | −2.15 | Waukesha | 5.60 | Mauston | .05 |
| Wyoming | 58.1 | +8.8 | 2 stations | 101 | 28 | Dome Lake | 6 | 13 | .52 | −1.56 | Foxpark | 2.43 | Eden | .00 |
| Alaska (April) | 32.5 | +4.8 | Seclusion Harbor | 74 | 24 | Allakaket | −28 | 10 | 1.70 | +.26 | Cordova | 13.18 | Tanana | T |
| Hawaii | 72.2 | +.5 | 2 stations | 91 | [1] 27 | Kanalohuluhulu | 46 | [1] 9 | 9.20 | +3.24 | Puohakamoa No. 2 | 38.60 | Olowalu | .00 |
| Puerto Rico | 76.6 | −.6 | Canovanas | 95 | 29 | Guineo Reservoir | 46 | 18 | 4.58 | −1.97 | Lares | 14.05 | Mona Island | .95 |

[1] Other dates also.

## TABLE 1.—*Climatological data for Weather Bureau Stations, May 1934*

[Compiled by Annie E. Small]

| District and station | Elevation of instruments: Barometer above sea level | Elevation of instruments: Thermometer above ground | Elevation of instruments: Anemometer above ground | Pressure: Station, reduced to mean of 24 hours | Pressure: Sea level, reduced to mean of 24 hours | Pressure: Departure from normal | Temperature of the air: Mean max.+mean min.÷2 | Temperature of the air: Departure from normal | Temperature of the air: Maximum | Temperature of the air: Date | Temperature of the air: Mean maximum | Temperature of the air: Minimum | Temperature of the air: Date | Temperature of the air: Mean minimum | Temperature of the air: Greatest daily range | Mean wet thermometer | Mean temperature of the dew point | Mean relative humidity | Precipitation: Total | Precipitation: Departure from normal | Precipitation: Days with 0.01, or more | Wind: Total movement | Wind: Prevailing direction | Wind: Maximum velocity: Miles per hour | Wind: Maximum velocity: Direction | Wind: Maximum velocity: Date | Clear days | Partly cloudy days | Cloudy days | Average cloudiness, tenths | Total snowfall | Snow, sleet, and ice on ground at end of month |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Ft.* | *Ft.* | *Ft.* | *In.* | *In.* | *In.* | °F. | °F. | °F. | | °F. | °F. | | °F. | °F. | °F. | °F. | % | *In.* | *In.* | | *Miles* | | | | | | | | *0–10* | *In.* | *In.* |
| *New England* | | | | | | | 57.2 | +2.6 | | | | | | | | | | 69 | 2.71 | −0.5 | | | | | | | | | | 5.3 | | |
| Eastport | 76 | 67 | 85 | 29.88 | 29.96 | 0.00 | 50.0 | +2.3 | 80 | 31 | 58 | 36 | 9 | 42 | 32 | 45 | 41 | 75 | 1.51 | −1.5 | 11 | 7,191 | sw. | 32 | sw. | 10 | 10 | 11 | 10 | 5.7 | 0.0 | 0.0 |
| Greenville, Maine | 1,070 | 6 | 40 | 28.80 | 29.96 | ..... | 52.4 | ..... | 83 | 2 | 65 | 27 | 9 | 39 | 45 | ..... | ..... | ..... | 1.74 | ..... | 8 | 4,319 | se. | 18 | ..... | 11 | 10 | 12 | 9 | ..... | .0 | .0 |
| Portland, Maine | 103 | 82 | 117 | 29.85 | 29.97 | .00 | 56.2 | +2.9 | 87 | 31 | 65 | 39 | 9 | 47 | 31 | 48 | 41 | 62 | 2.20 | −1.2 | 9 | 6,708 | sw. | 28 | sw. | 17 | 19 | 6 | 6 | 3.9 | .0 | .0 |
| Concord | 289 | 60 | ..... | ..... | ..... | ..... | 58.2 | +3.9 | 86 | 5 | 72 | 30 | 9 | 45 | 43 | ..... | ..... | ..... | 2.68 | −.3 | 8 | ..... | nw. | ..... | ..... | ..... | 13 | 12 | 6 | ..... | .0 | .0 |
| Burlington | 403 | 11 | 48 | 29.55 | 29.98 | +.01 | 56.8 | +.3 | 84 | 22 | 69 | 31 | 9 | 45 | 39 | ..... | ..... | ..... | 1.02 | −1.8 | 10 | 7,055 | s. | 36 | s. | 10 | 10 | 12 | 9 | 5.0 | .0 | .0 |
| Northfield | 876 | 12 | 60 | ..... | 29.98 | +.01 | 54.3 | +1.5 | 85 | 22 | 69 | 25 | 13 | 39 | 44 | ..... | ..... | 70 | 1.05 | −1.7 | 6 | 5,649 | s. | 38 | sw. | 22 | 8 | 16 | 7 | 5.4 | .0 | .0 |
| Boston | 124 | 336 | 360 | 29.84 | 29.98 | .00 | 60.6 | +3.5 | 87 | 22 | 70 | 41 | 1 | 51 | 33 | 52 | 44 | 60 | 1.56 | −1.6 | 11 | 9,874 | sw. | 40 | sw. | 22 | 11 | 14 | 6 | 4.9 | .0 | .0 |
| Nantucket | 12 | 14 | 90 | 29.98 | 29.99 | .00 | 55.4 | +3.1 | 73 | 7 | 62 | 39 | 1 | 49 | 25 | 50 | 47 | 80 | 2.23 | −.6 | 13 | 10,478 | sw. | 43 | s. | 10 | 12 | 8 | 11 | 5.8 | .0 | .0 |
| Block Island | 26 | 11 | 46 | 29.96 | 29.99 | .00 | 54.9 | +2.1 | 76 | 6 | 61 | 40 | 1 | 48 | 25 | 51 | 48 | 82 | 3.32 | −.2 | 16 | 10,274 | sw. | 32 | se. | 3 | 10 | 12 | 9 | 5.4 | .0 | .0 |
| Providence | 160 | 215 | 251 | 29.82 | 29.99 | +.01 | 60.9 | +2.4 | 87 | 31 | 71 | 39 | 1 | 51 | 29 | 52 | 44 | 60 | 3.50 | +.5 | 11 | 8,171 | nw. | 34 | nw. | 7 | 14 | 8 | 9 | 4.7 | .0 | .0 |
| Hartford | 159 | 70 | 104 | ..... | 30.00 | +.02 | 61.4 | +3.9 | 88 | 6 | 72 | 38 | 1 | 50 | 33 | ..... | ..... | ..... | 5.53 | +1.9 | 15 | 5,779 | s. | ..... | ..... | ..... | 8 | 14 | 9 | ..... | .0 | .0 |
| New Haven | 106 | 74 | 153 | 29.89 | 30.00 | +.01 | 60.4 | +2.5 | 87 | 6 | 70 | 40 | 1 | 51 | 27 | 53 | 47 | 65 | 5.23 | +1.5 | 14 | 6,434 | s. | 27 | sw. | 22 | 8 | 13 | 10 | 5.8 | .0 | .0 |
| *Middle Atlantic States* | | | | | | | 64.1 | +1.8 | | | | | | | | | | 66 | 4.01 | +0.6 | | | | | | | | | | 5.3 | | |
| Albany | 97 | 107 | 115 | 29.88 | 29.98 | .00 | 61.2 | +1.9 | 89 | 31 | 73 | 37 | 13 | 50 | 32 | 54 | 48 | 66 | 2.56 | −.3 | 9 | 5,440 | s. | 26 | se. | 22 | 11 | 13 | 7 | 4.9 | .0 | .0 |
| Binghamton | 871 | 60 | 68 | 29.09 | 30.02 | +.04 | 59.3 | +1.9 | 90 | 21 | 73 | 31 | 13 | 45 | 43 | ..... | ..... | ..... | 2.11 | −1.2 | 9 | 4,193 | nw. | 21 | nw. | 7 | 9 | 8 | 14 | 5.8 | .0 | .0 |
| New York | 314 | 414 | 454 | 29.66 | 29.99 | .00 | 62.6 | +2.0 | 88 | 21 | 72 | 43 | 1 | 53 | 33 | 54 | 47 | 64 | 4.05 | +.8 | 14 | 9,162 | sw. | 46 | w. | 21 | 9 | 14 | 8 | 5.5 | .0 | .0 |
| Bellefonte | 1,050 | 5 | 42 | 28.90 | 30.00 | ..... | 59.4 | ..... | 92 | 20 | 74 | 34 | 8 | 44 | 39 | 53 | 47 | 62 | 1.06 | ..... | 10 | ..... | sw. | 33 | w. | 10 | 8 | 16 | 7 | 5.4 | .0 | .0 |
| Harrisburg | 374 | 94 | 104 | 29.60 | 29.99 | +.01 | 63.9 | +2.1 | 91 | 20 | 74 | 43 | 1 | 54 | 33 | 55 | 48 | 60 | 3.63 | +.2 | 11 | 5,366 | ne. | 30 | s. | 10 | 7 | 17 | 7 | 5.1 | .0 | .0 |
| Philadelphia | 114 | 123 | 367 | 29.89 | 30.01 | +.02 | 66.1 | +3.2 | 95 | 21 | 76 | 47 | 1 | 57 | 37 | 55 | 48 | 58 | 3.92 | +.7 | 10 | 9,392 | sw. | 39 | sw. | 10 | 10 | 12 | 9 | 5.5 | .0 | .0 |
| Reading | 323 | 283 | 306 | 29.65 | 30.00 | ..... | 64.6 | +2.1 | 93 | 21 | 75 | 40 | 13 | 54 | 36 | 56 | 50 | 63 | 3.03 | −.6 | 10 | 7,627 | sw. | 46 | sw. | 22 | 8 | 16 | 7 | 5.4 | .0 | .0 |
| Scranton | 805 | 72 | 104 | 29.14 | 30.00 | +.02 | 62.0 | +2.6 | 92 | 21 | 74 | 35 | 13 | 50 | 37 | 54 | 48 | 64 | 3.32 | .0 | 11 | 5,034 | sw. | 28 | nw. | 10 | 7 | 17 | 7 | 5.3 | .0 | .0 |
| Atlantic City | 52 | 37 | 172 | 29.94 | 30.00 | +.02 | 59.6 | +1.5 | 89 | 7 | 66 | 46 | 13 | 53 | 34 | 54 | 51 | 79 | 4.88 | +1.8 | 14 | 12,273 | s. | 41 | ne. | 26 | 10 | 6 | 15 | 6.2 | .0 | .0 |
| Sandy Hook | 22 | 10 | 57 | 29.97 | 29.99 | ..... | 60.2 | ..... | 84 | 22 | 68 | 42 | 1 | 52 | 31 | 54 | 49 | 72 | 3.56 | −.2 | 14 | 8,837 | s. | 35 | w. | 22 | 11 | 10 | 10 | 5.5 | .0 | .0 |
| Trenton | 190 | 88 | 106 | 29.79 | 29.99 | ..... | 63.2 | +2.1 | 94 | 21 | 74 | 41 | 1 | 52 | 37 | 55 | 48 | 63 | 4.79 | +1.7 | 12 | 7,105 | n. | 37 | s. | 10 | 6 | 14 | 11 | 5.8 | .0 | .0 |
| Baltimore | 123 | 100 | 215 | 29.87 | 30.00 | +.01 | 67.2 | +2.8 | 96 | 21 | 76 | 48 | 1 | 58 | 39 | 57 | 50 | 61 | 4.04 | +.5 | 10 | 7,921 | ne. | 35 | nw. | 21 | 10 | 11 | 10 | 5.3 | .0 | .0 |
| Washington | 112 | 62 | 85 | 29.88 | 30.00 | .00 | 66.5 | +2.8 | 95 | 21 | 77 | 47 | 1 | 56 | 40 | 57 | 50 | 63 | 3.85 | +.2 | 12 | 5,224 | s. | 30 | nw. | 10 | 12 | 11 | 8 | 5.3 | .0 | .0 |
| Cape Henry | 18 | 8 | 54 | 29.97 | 29.99 | ..... | 65.6 | +1.4 | 94 | 20 | 73 | 48 | 9 | 58 | 33 | 60 | 57 | 76 | 6.73 | +3.2 | 11 | 9,887 | sw. | 35 | ne. | 28 | 12 | 8 | 11 | 5.0 | .0 | .0 |
| Lynchburg | 686 | 5 | ..... | 29.28 | 30.02 | +.02 | 67.2 | −.1 | 96 | 20 | 81 | 41 | 26 | 54 | 47 | ..... | ..... | ..... | 4.09 | +.5 | 11 | ..... | s. | ..... | ..... | ..... | 6 | 19 | 6 | ..... | .0 | .0 |
| Norfolk | 91 | 170 | 205 | 29.91 | 30.01 | +.01 | 67.0 | +.8 | 90 | 7 | 75 | 51 | 9 | 59 | 33 | 61 | 58 | 78 | 6.96 | +3.2 | 11 | 9,744 | ne. | 32 | n. | 25 | 11 | 7 | 13 | 5.7 | .0 | .0 |
| Richmond | 144 | 11 | 52 | 29.86 | 30.01 | +.02 | 67.0 | +.5 | 95 | 20 | 77 | 47 | 18 | 57 | 39 | 59 | 54 | 68 | 4.83 | +1.0 | 12 | 6,551 | ne. | 24 | sw. | 10 | 13 | 5 | 13 | 4.9 | .0 | .0 |
| Wytheville | 2,304 | 49 | 55 | 27.66 | 29.99 | .00 | 62.3 | +.9 | 89 | 19 | 75 | 38 | 26 | 50 | 38 | 54 | 47 | 61 | 1.84 | −1.8 | 10 | 4,400 | e. | 21 | w. | 5 | 16 | 10 | 5 | 4.1 | .0 | .0 |
| *South Atlantic States* | | | | | | | 69.4 | −1.1 | | | | | | | | | | 74 | 5.62 | +2.2 | | | | | | | | | | 5.4 | | |
| Asheville | 2,253 | 89 | 104 | 27.70 | 30.01 | +.02 | 64.2 | +1.6 | 87 | 20 | 77 | 41 | 1 | 52 | 35 | 55 | 49 | 65 | 2.29 | −1.1 | 9 | 5,366 | nw. | 20 | e. | 16 | 10 | 12 | 9 | 5.0 | .0 | .0 |
| Charlotte | 779 | 244 | 267 | 29.18 | 30.01 | +.02 | 67.7 | −1.2 | 88 | 19 | 77 | 48 | 17 | 58 | 30 | 58 | 52 | 66 | 3.22 | −.4 | 8 | 9,108 | ne. | 44 | ne. | 28 | 14 | 8 | 9 | 4.6 | .0 | .0 |
| Greensboro | 886 | 6 | 56 | 29.07 | 30.02 | ..... | 66.2 | ..... | 91 | 7 | 78 | 44 | 18 | 54 | 43 | 58 | 53 | 69 | 4.63 | ..... | 9 | 7,150 | ne. | 47 | ne. | 28 | 9 | 13 | 9 | 5.0 | .0 | .0 |
| Hatteras | 11 | 5 | 50 | 29.99 | 30.00 | −.01 | 67.5 | −1.2 | 80 | 21 | 72 | 55 | 17 | 63 | 15 | 63 | 61 | 81 | 10.37 | +6.7 | 13 | 9,766 | sw. | 32 | ne. | 2 | 14 | 8 | 9 | 4.5 | .0 | .0 |
| Raleigh | 376 | 103 | 146 | 29.61 | 30.00 | +.01 | 67.7 | −.8 | 91 | 5 | 78 | 45 | 17 | 58 | 33 | 60 | 56 | 72 | 4.68 | +.9 | 13 | 7,029 | sw. | 25 | sw. | 21 | 9 | 7 | 15 | 5.9 | .0 | .0 |
| Wilmington | 72 | 73 | 107 | 29.93 | 30.00 | −.01 | 68.2 | −2.6 | 88 | 5 | 76 | 49 | 17 | 60 | 26 | 63 | 60 | 79 | 5.58 | +2.1 | 11 | 7,430 | s. | 30 | s. | 29 | 12 | 10 | 9 | 5.1 | .0 | .0 |
| Charleston | 48 | 11 | 92 | 29.93 | 29.98 | −.03 | 71.0 | −1.7 | 89 | 5 | 78 | 56 | 17 | 64 | 26 | 66 | 63 | 80 | 5.41 | +2.4 | 7 | 9,207 | e. | 53 | se. | 28 | 7 | 12 | 12 | 5.7 | .0 | .0 |
| Columbia, S.C. | 351 | 41 | 57 | 29.62 | 29.99 | −.01 | 69.7 | −2.2 | 89 | 5 | 79 | 50 | 18 | 60 | 32 | 62 | 58 | 74 | 3.61 | +.5 | 12 | 5,485 | ne. | 26 | ne. | 28 | 13 | 5 | 13 | 5.0 | .0 | .0 |
| Augusta | 182 | 62 | 77 | 29.79 | 29.98 | −.01 | 70.8 | −1.6 | 89 | 5 | 81 | 52 | 18 | 61 | 30 | 63 | 58 | 68 | 5.72 | +2.7 | 11 | 4,685 | ne. | 24 | n. | 28 | 12 | 8 | 11 | 5.0 | .0 | .0 |
| Savannah | 65 | 73 | 152 | 29.90 | 29.97 | −.03 | 72.7 | −.7 | 93 | 8 | 82 | 54 | 28 | 64 | 27 | 66 | 63 | 81 | 9.02 | +6.0 | 10 | 8,069 | e. | 39 | nw. | 28 | 5 | 13 | 13 | 6.5 | .0 | .0 |
| Jacksonville | 43 | 86 | 110 | 29.92 | 29.97 | −.03 | 74.0 | −1.0 | 90 | 23 | 81 | 54 | 28 | 67 | 21 | 67 | 65 | 81 | 6.33 | +2.3 | 13 | 6,550 | ne. | 24 | n. | 28 | 4 | 9 | 18 | 7.3 | .0 | .0 |
| *Florida Peninsula* | | | | | | | 78.4 | +1.1 | | | | | | | | | | 79 | 8.19 | +4.0 | | | | | | | | | | 5.8 | | |
| Key West | 22 | 10 | 64 | 29.91 | 29.93 | −.04 | 80.2 | +1.1 | 90 | 15 | 86 | 69 | 2 | 75 | 17 | 74 | 71 | 77 | 4.70 | +1.2 | 9 | 6,830 | se. | 29 | w. | 28 | 9 | 14 | 8 | 5.4 | .0 | .0 |
| Miami | 25 | 124 | 168 | 29.93 | 29.96 | −.03 | 77.7 | +1.3 | 90 | 23 | 83 | 67 | 29 | 72 | 17 | 72 | 70 | 80 | 16.10 | +9.9 | 20 | 6,831 | se. | 35 | sw. | 27 | 1 | 14 | 16 | 7.2 | .0 | .0 |
| Tampa | 35 | 88 | 197 | 29.92 | 29.95 | −.04 | 77.2 | +.9 | 90 | 20 | 85 | 59 | 28 | 69 | 22 | 70 | 68 | 80 | 3.78 | +.8 | 9 | 7,883 | e. | 34 | n. | 28 | 11 | 13 | 7 | 4.7 | .0 | .0 |
| Titusville | 43 | 5 | 36 | 29.91 | 29.96 | ..... | 75.8 | ..... | 91 | 25 | 85 | 56 | 28 | 67 | 27 | ..... | ..... | ..... | 5.98 | ..... | 13 | ..... | e. | ..... | ..... | ..... | 7 | 10 | 14 | ..... | .0 | .0 |
| *East Gulf States* | | | | | | | 72.4 | 0.0 | | | | | | | | | | 74 | 4.60 | +0.7 | | | | | | | | | | 5.4 | | |
| Atlanta | 1,173 | 190 | 198 | 28.78 | 30.00 | +.01 | 69.0 | −.9 | 85 | 8 | 78 | 52 | 1 | 60 | 24 | 61 | 56 | 69 | 3.26 | −.2 | 10 | 6,588 | se. | 26 | nw. | 29 | 13 | 12 | 6 | 4.8 | .0 | .0 |
| Macon | 370 | 76 | 84 | 29.59 | 29.98 | −.01 | 70.9 | −1.4 | 90 | 8 | 81 | 53 | 3 | 61 | 32 | 63 | 59 | 71 | 4.85 | +1.9 | 10 | 4,987 | e. | 20 | n. | 29 | 11 | 10 | 10 | 5.4 | .0 | .0 |
| Thomasville | 273 | 49 | 58 | 29.68 | 29.97 | −.02 | 73.0 | −1.0 | 90 | 23 | 82 | 56 | 28 | 63 | 26 | 66 | 63 | 77 | 8.17 | ..... | 16 | ..... | e. | ..... | ..... | ..... | 5 | 8 | 18 | ..... | .0 | .0 |
| Apalachicola | 35 | 11 | 51 | 29.91 | 29.95 | ..... | 74.0 | ..... | 89 | 23 | 80 | 58 | 28 | 68 | 21 | 69 | ..... | ..... | 6.91 | +3.5 | 8 | ..... | w. | ..... | ..... | ..... | 7 | 16 | 8 | ..... | .0 | .0 |
| Pensacola | 56 | 149 | 185 | 29.90 | 29.96 | −.03 | 73.0 | −.9 | 86 | 30 | 78 | 58 | 28 | 68 | 21 | 68 | 66 | 80 | 3.71 | +.3 | 14 | 8,856 | e. | 56 | ne. | 31 | 13 | 9 | 9 | 5.0 | .0 | .0 |
| Anniston | 741 | 9 | ..... | ..... | ..... | ..... | 70.8 | +2.4 | 90 | 8 | 82 | 49 | 28 | 59 | 35 | ..... | ..... | ..... | 1.82 | −2.1 | 6 | ..... | se. | ..... | ..... | ..... | 17 | 8 | 6 | ..... | .0 | .0 |
| Birmingham | 700 | 11 | 48 | 29.23 | 29.98 | .00 | 72.1 | +1.0 | 91 | 31 | 83 | 52 | 28 | 62 | 28 | 62 | 57 | 67 | 2.26 | −1.7 | 8 | 4,741 | e. | 18 | s. | 5 | 10 | 14 | 7 | 4.8 | .0 | .0 |
| Mobile | 57 | 125 | 161 | 29.89 | 29.95 | −.04 | 74.0 | −.4 | 90 | 30 | 82 | 56 | 28 | 66 | 26 | 67 | 65 | 78 | 5.63 | +1.3 | 13 | 6,784 | e. | 30 | nw. | 23 | 10 | 11 | 10 | 5.5 | .0 | .0 |
| Montgomery | 218 | 92 | 106 | 29.73 | 29.98 | −.01 | 73.4 | .0 | 91 | 31 | 83 | 56 | 1 | 64 | 28 | 65 | 60 | 69 | 4.50 | +.7 | 11 | 5,059 | e. | 25 | sw. | 5 | 9 | 10 | 12 | 6.1 | .0 | .0 |
| Meridian | 375 | 67 | 92 | 29.58 | 29.96 | −.02 | 72.4 | +1.1 | 95 | 31 | 83 | 54 | 3 | 62 | 33 | 64 | 60 | 73 | 3.79 | −.5 | 12 | 3,997 | ne. | 20 | w. | 23 | 11 | 12 | 8 | 5.0 | .0 | .0 |
| Vicksburg | 247 | 65 | 73 | 29.71 | 29.97 | .00 | 73.2 | +.3 | 94 | 31 | 83 | 55 | 26 | 64 | 26 | 65 | 62 | 75 | 3.47 | −.8 | 9 | 5,025 | e. | 25 | s. | 5 | 7 | 10 | 14 | 6.1 | .0 | .0 |
| New Orleans | 53 | 76 | 84 | 29.90 | 29.95 | −.02 | 74.8 | −.6 | 90 | 23 | 82 | 62 | 1 | 68 | 22 | 68 | 65 | 78 | 10.39 | +5.8 | 16 | 4,971 | e. | 21 | n. | 5 | 11 | 12 | 8 | 5.5 | .0 | .0 |
| *West Gulf States* | | | | | | | 74.1 | +0.8 | | | | | | | | | | 70 | 2.00 | −2.1 | | | | | | | | | | 3.8 | | |
| Shreveport | 249 | 92 | 227 | 29.70 | 29.97 | +.02 | 73.6 | .0 | 95 | 31 | 83 | 51 | 1 | 64 | 28 | 65 | 61 | 72 | 4.46 | +.2 | 10 | 6,984 | ne. | 35 | s. | 5 | 13 | 11 | 7 | 4.2 | .0 | .0 |
| Bentonville | 1,303 | 11 | 44 | 28.63 | 29.98 | +.05 | 67.4 | +1.0 | 96 | 31 | 80 | 44 | 27 | 55 | 36 | ..... | ..... | ..... | 2.97 | ..... | 9 | 3,796 | s. | 18 | s. | 3 | 14 | 8 | 9 | ..... | .0 | .0 |
| Fort Smith | 457 | 79 | 94 | 29.49 | 29.96 | +.03 | 71.9 | +2.3 | 99 | 31 | 83 | 52 | 26 | 60 | 33 | 61 | 55 | 63 | 2.44 | −2.4 | 9 | 5,041 | e. | 27 | se. | 4 | 14 | 8 | 9 | 4.4 | .0 | .0 |
| Little Rock | 357 | 94 | 102 | 29.61 | 29.98 | +.03 | 71.3 | +1.0 | 97 | 31 | 81 | 53 | 1 | 62 | 33 | 62 | 56 | 64 | 2.74 | −2.0 | 10 | 5,251 | e. | 31 | sw. | 31 | 14 | 10 | 7 | 4.3 | .0 | .0 |
| Austin | 605 | 136 | 148 | 29.30 | 29.93 | ..... | 75.5 | +.9 | 96 | 30 | 87 | 53 | 17 | 64 | 35 | 65 | 60 | 65 | 1.75 | −2.9 | 7 | 5,458 | se. | 29 | n. | 23 | 15 | 11 | 5 | 3.8 | .0 | .0 |
| Brownsville | 57 | 88 | 96 | 29.84 | 29.90 | ..... | 78.0 | −.6 | 93 | 24 | 86 | 63 | 16 | 70 | 26 | 70 | 68 | 79 | 1.50 | −.8 | 6 | 6,862 | se. | 23 | se. | 2 | 18 | 12 | 1 | 3.4 | .0 | .0 |
| Corpus Christi | 20 | 11 | 78 | 29.91 | 29.94 | +.04 | 76.8 | +.6 | 90 | 6 | 84 | 58 | 16 | 70 | 27 | 70 | 67 | 76 | 1.24 | −2.0 | 5 | 7,878 | se. | 27 | e. | 6 | 15 | 11 | 5 | 3.8 | .0 | .0 |
| Dallas | 512 | 220 | 227 | 29.40 | 29.94 | ..... | 73.4 | ..... | 94 | 31 | 83 | 53 | 16 | 64 | 29 | 63 | 58 | 64 | .96 | −3.5 | 5 | 8,268 | se. | 30 | ne. | 24 | 16 | 5 | 10 | 4.3 | .0 | .0 |
| Fort Worth | 670 | 106 | 114 | 29.26 | 29.96 | +.05 | 74.4 | +2.1 | 97 | 30 | 85 | 54 | 16 | 64 | 31 | ..... | ..... | ..... | .82 | −3.8 | 5 | 6,295 | se. | 26 | nw. | 14 | 22 | 6 | 3 | 2.6 | .0 | .0 |
| Galveston | 54 | 106 | 114 | 29.88 | 29.94 | .00 | 75.4 | +.6 | 87 | 7 | 80 | 61 | 16 | 71 | 15 | 69 | 66 | 77 | .62 | −2.8 | 4 | 7,558 | se. | 21 | nw. | 15 | 18 | 12 | 1 | 3.0 | .0 | .0 |
| Houston | 138 | 292 | 314 | 29.80 | 29.95 | ..... | 74.8 | −.7 | 92 | 30 | 83 | 56 | 16 | 66 | 22 | ..... | ..... | ..... | 1.70 | −2.8 | 6 | 8,236 | se. | 31 | se. | 2 | 16 | 11 | 4 | 3.8 | .0 | .0 |
| Palestine | 510 | 64 | 72 | 29.44 | 29.96 | +.03 | 72.9 | +.2 | 93 | 30 | 83 | 56 | 26 | 63 | 31 | 65 | 60 | 70 | 3.46 | −1.1 | 9 | 5,243 | ne. | 24 | s. | 4 | 15 | 9 | 7 | 4.1 | .0 | .0 |
| Port Arthur | 34 | 58 | 66 | 29.91 | 29.95 | ..... | 75.4 | ..... | 89 | 29 | 83 | 59 | 27 | 68 | 25 | ..... | ..... | ..... | 2.67 | −1.4 | 7 | 6,077 | e. | 24 | ne. | 7 | 13 | 17 | 1 | 4.0 | .0 | .0 |
| San Antonio | 693 | 242 | 301 | 29.20 | 29.90 | .00 | 76.7 | +1.6 | 97 | 30 | 87 | 58 | 16 | 66 | 30 | 66 | 61 | 65 | 1.65 | −1.6 | 8 | 8,016 | e. | 35 | se. | 2 | 15 | 12 | 4 | 4.0 | .0 | .0 |

TABLE 1.—*Climatological data for Weather Bureau stations, May 1934*—Continued

| District and station | Elevation of instruments: Barometer above sea level | Elevation of instruments: Thermometer above ground | Elevation of instruments: Anemometer above ground | Pressure: Station, reduced to mean of 24 hours | Pressure: Sea level, reduced to mean of 24 hours | Pressure: Departure from normal | Temperature of the air: Mean max.+mean min.÷2 | Temperature of the air: Departure from normal | Temperature of the air: Maximum | Temperature of the air: Date | Temperature of the air: Mean maximum | Temperature of the air: Minimum | Temperature of the air: Date | Temperature of the air: Mean minimum | Temperature of the air: Greatest daily range | Mean wet thermometer | Mean temperature of the dew-point | Mean relative humidity | Precipitation: Total | Precipitation: Departure from normal | Precipitation: Days with 0.01 or more | Wind: Total movement | Wind: Prevailing direction | Wind: Maximum velocity: Miles per hour | Wind: Maximum velocity: Direction | Wind: Maximum velocity: Date | Clear days | Partly cloudy days | Cloudy days | Average cloudiness, tenths | Total snowfall | Snow, sleet, and ice on ground at end of month |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Ohio Valley and Tennessee* | *Ft.* | *Ft.* | *Ft.* | *In.* | *In.* | *In.* | °F. 67.6 | °F. +2.5 | °F. | | °F. 56 | °F. | | °F. 33 | °F. 61 | °F. 55 | % 60 | *In.* 1.77 | *In.* −2.0 | 8 | *Miles* 5,035 | ne. | 32 | sw. | 10 | 12 | 11 | 8 | *0–10* 4.2 | *In.* 4.7 | *In.* .0 |
| Chattanooga | 762 | 71 | 214 | 29.20 | 30.00 | +0.01 | 71.4 | +2.6 | 92 | 19 | 82 | 49 | 1 | 60 | 33 | 61 | 55 | 60 | 1.83 | −2.0 | 8 | 5,035 | ne. | 32 | sw. | 10 | 12 | 11 | 8 | 4.7 | .0 | .0 |
| Knoxville | 995 | 66 | 84 | 28.96 | 30.00 | +.01 | 69.2 | +2.0 | 91 | 20 | 81 | 50 | 1 | 57 | 35 | 59 | 53 | 63 | 4.41 | +.7 | 8 | 4,164 | ne. | 24 | w. | 5 | 19 | 8 | 4 | 3.4 | .0 | .0 |
| Memphis | 399 | 78 | 86 | 29.56 | 29.98 | +.02 | 73.1 | +2.5 | 98 | 31 | 82 | 53 | 26 | 64 | 27 | 62 | 55 | 58 | 2.54 | −1.6 | 6 | 4,536 | ne. | 27 | w. | 21 | 15 | 8 | 8 | 4.1 | .0 | .0 |
| Nashville | 546 | 168 | 191 | 29.44 | 30.02 | +.04 | 70.0 | +1.8 | 91 | 31 | 81 | 52 | 25 | 59 | 33 | 60 | 53 | 60 | 1.61 | −2.3 | 5 | 5,972 | ne. | 25 | n. | 29 | 7 | 17 | 7 | 5.4 | .0 | .0 |
| Lexington | 989 | 5 | ---- | ---- | ---- | ---- | 66.5 | +2.2 | 91 | 21 | 80 | 43 | 26 | 54 | 35 | ---- | ---- | ---- | 1.52 | −2.3 | 5 | ---- | e. | ---- | ---- | ---- | 19 | 7 | 5 | ---- | .0 | .0 |
| Louisville | 525 | 188 | 234 | 29.45 | 30.03 | +.05 | 68.6 | +2.0 | 91 | 31 | 79 | 45 | 25 | 58 | 29 | 58 | 49 | 54 | 3.25 | −.5 | 6 | 6,288 | n. | 30 | n. | 24 | 14 | 12 | 5 | 3.9 | .0 | .0 |
| Evansville | 431 | 76 | 116 | 29.55 | 30.01 | +.04 | 70.2 | +3.5 | 95 | 31 | 81 | 44 | 25 | 60 | 31 | 58 | 50 | 52 | 2.12 | −1.7 | 6 | 5,433 | ne. | 24 | n. | 24 | 13 | 12 | 6 | 4.2 | .0 | .0 |
| Indianapolis | 822 | 194 | 230 | 29.16 | 30.04 | +.07 | 67.4 | +4.5 | 94 | 31 | 79 | 40 | 12 | 56 | 34 | 55 | 45 | 48 | .60 | −3.3 | 5 | 7,112 | sw. | 30 | w. | 10 | 14 | 13 | 4 | 4.0 | .0 | .0 |
| Terre Haute | 575 | 96 | 129 | 29.40 | 30.02 | ---- | 67.6 | ---- | 95 | 31 | 80 | 38 | 25 | 55 | 36 | 56 | 46 | 49 | .44 | −3.4 | 4 | 6,506 | sw. | 29 | n. | 24 | 19 | 7 | 5 | 3.3 | .0 | .0 |
| Cincinnati | 627 | 11 | 51 | 29.35 | 30.02 | +.03 | 66.7 | +3.6 | 92 | 31 | 79 | 42 | 25 | 55 | 37 | 56 | 48 | 55 | .98 | −2.7 | 5 | 4,862 | sw. | 21 | w. | 10 | 13 | 12 | 6 | 4.3 | .0 | .0 |
| Columbus | 822 | 216 | 230 | 29.16 | 30.02 | +.04 | 66.2 | +3.9 | 92 | 31 | 78 | 39 | 12 | 55 | 30 | 55 | 46 | 51 | .60 | −3.0 | 6 | 6,972 | ne. | 31 | w. | 10 | 13 | 12 | 5 | 3.7 | .0 | .0 |
| Elkins | 1,947 | 59 | 78 | 28.02 | 30.05 | +.05 | 59.5 | +.3 | 87 | 21 | 74 | 33 | 26 | 45 | 41 | 52 | 46 | 64 | 2.16 | −1.9 | 8 | 4,148 | n. | 28 | w. | 10 | 9 | 9 | 13 | 5.7 | .0 | .0 |
| Parkersburg | 637 | 77 | 84 | 29.40 | 30.05 | +.06 | 65.8 | +2.0 | 93 | 21 | 79 | 43 | 16 | 53 | 38 | 56 | 49 | 57 | 2.09 | −1.3 | 6 | 4,142 | nw. | 36 | w. | 10 | 18 | 7 | 6 | 3.9 | .0 | .0 |
| Pittsburgh | 842 | 353 | 410 | 29.12 | 30.02 | +.03 | 64.6 | +2.2 | 89 | 20 | 76 | 39 | 12 | 53 | 31 | 54 | 45 | 51 | .66 | −2.6 | 5 | 6,465 | sw. | 30 | nw. | 21 | 17 | 9 | 5 | 4.0 | .0 | .0 |
| *Lower Lake Region* | | | | | | | 60.4 | +2.9 | | | | | | | | | | 54 | 0.71 | −2.5 | | | | | | | | | 4.0 | 4.0 | |
| Buffalo | 768 | 243 | 280 | 29.17 | 30.00 | +.03 | 56.8 | +2.2 | 82 | 31 | 66 | 35 | 12 | 48 | 30 | 49 | 43 | 63 | .54 | −2.6 | 4 | 8,924 | sw. | 45 | sw. | 10 | 15 | 12 | 4 | 4.0 | .0 | .0 |
| Canton | 448 | 10 | 61 | 29.47 | 29.95 | ---- | 56.5 | +.3 | 84 | 4 | 69 | 29 | 8 | 44 | 36 | ---- | ---- | ---- | .77 | −2.2 | 11 | 6,289 | sw. | 31 | w. | 10 | 15 | 9 | 7 | 4.5 | T | .0 |
| Ithaca | 836 | 77 | 100 | 29.10 | 30.00 | ---- | 59.9 | +2.4 | 90 | 21 | 75 | 31 | 13 | 45 | 41 | 51 | 42 | 54 | .53 | −2.9 | 7 | 5,980 | nw. | 27 | w. | 10 | 11 | 10 | 10 | 5.0 | .0 | .0 |
| Oswego | 335 | 71 | 85 | 29.63 | 30.00 | +.03 | 55.7 | +.5 | 81 | 10 | 66 | 35 | 13 | 45 | 33 | 48 | 41 | 60 | 1.15 | −1.9 | 7 | 5,899 | w. | 21 | sw. | 10 | 9 | 13 | 9 | 5.1 | .0 | .0 |
| Rochester | 523 | 86 | 102 | 29.44 | 30.01 | +.04 | 59.6 | +2.5 | 88 | 21 | 71 | 36 | 16 | 48 | 30 | 49 | 39 | 47 | .52 | −2.4 | 4 | 5,919 | nw. | 34 | w. | 10 | 16 | 12 | 3 | 3.3 | .0 | .0 |
| Syracuse | 596 | 65 | 79 | 29.39 | 30.03 | +.05 | 60.4 | +3.1 | 85 | 31 | 73 | 35 | 13 | 48 | 36 | ---- | ---- | ---- | .80 | −2.2 | 7 | 5,161 | nw. | 21 | nw. | 7 | 8 | 17 | 6 | 5.2 | .0 | .0 |
| Erie | 714 | 130 | 166 | 29.25 | 30.01 | +.03 | 60.8 | +4.0 | 87 | 21 | 70 | 36 | 12 | 51 | 29 | 53 | 47 | 60 | .55 | −2.8 | 3 | 7,918 | n. | 40 | w. | 10 | 19 | 7 | 5 | 3.3 | .0 | .0 |
| Cleveland | 762 | 267 | 337 | 29.20 | 30.02 | +.04 | 62.6 | +4.7 | 89 | 21 | 72 | 38 | 12 | 53 | 29 | 52 | 44 | 53 | .58 | −2.5 | 3 | 8,705 | n. | 36 | sw. | 13 | 20 | 8 | 3 | 3.1 | .0 | .0 |
| Sandusky | 629 | 5 | 67 | 29.37 | 30.05 | +.07 | 62.7 | +3.5 | 93 | 21 | 74 | 38 | 16 | 52 | 39 | ---- | ---- | ---- | .64 | −2.5 | 4 | 6,021 | ne. | 23 | nw. | 11 | 13 | 14 | 4 | 4.0 | .0 | .0 |
| Toledo | 628 | 79 | 87 | 29.35 | 30.03 | +.06 | 63.0 | +3.6 | 90 | 20 | 74 | 34 | 12 | 52 | 34 | 53 | 44 | 53 | .69 | −2.8 | 5 | 6,533 | w. | 24 | nw. | 10 | 20 | 7 | 4 | 3.1 | .0 | .0 |
| Fort Wayne | 857 | 69 | 84 | 29.10 | 30.02 | ---- | 64.9 | +4.7 | 92 | 31 | 77 | 35 | 12 | 53 | 36 | 54 | 44 | 50 | 1.20 | −2.6 | 6 | 6,067 | sw. | 27 | w. | 10 | 14 | 12 | 5 | 3.9 | .0 | .0 |
| Detroit | 626 | 5 | 78 | 29.34 | 30.02 | +.05 | 61.6 | +3.6 | 91 | 19 | 75 | 32 | 12 | 48 | 39 | 52 | 42 | 50 | .58 | −2.6 | 5 | 7,079 | sw. | 33 | sw. | 13 | 13 | 15 | 3 | 4.0 | .0 | .0 |
| *Upper Lake Region* | | | | | | | 57.3 | +4.7 | | | | | | | | | | 59 | 1.47 | −1.8 | | | | | | | | | 4.8 | | |
| Alpena | 609 | 13 | 89 | 29.32 | 29.99 | +.02 | 53.9 | +3.4 | 85 | 6 | 66 | 28 | 12 | 42 | 46 | 46 | 40 | 64 | 1.75 | −1.3 | 8 | 8,120 | nw. | 32 | nw. | 10 | 13 | 12 | 6 | 4.5 | T | .0 |
| Escanaba | 612 | 54 | 60 | 29.31 | 29.98 | +.01 | 51.8 | +2.2 | 88 | 6 | 61 | 30 | 12 | 43 | 48 | 45 | 39 | 65 | 1.68 | −1.2 | 11 | 7,856 | s. | 34 | nw. | 10 | 9 | 15 | 7 | 5.0 | .0 | .0 |
| Grand Rapids | 707 | 70 | 244 | 29.24 | 30.00 | +.03 | 63.6 | +5.6 | 95 | 31 | 76 | 33 | 12 | 51 | 31 | 52 | 43 | 50 | 1.96 | −1.5 | 6 | 8,561 | sw. | 34 | se. | 13 | 14 | 14 | 3 | 3.8 | .0 | .0 |
| Lansing | 878 | 6 | 88 | 29.07 | 30.00 | ---- | 60.0 | +3.1 | 88 | 31 | 74 | 28 | 12 | 46 | 37 | 53 | 46 | 61 | 1.33 | −2.1 | 6 | 6,706 | s. | 29 | nw. | 10 | 12 | 14 | 5 | 4.5 | .0 | .0 |
| Ludington | 637 | 5 | 54 | 29.29 | 29.99 | ---- | 55.8 | +3.6 | 85 | 31 | 66 | 29 | 12 | 46 | 33 | 48 | ---- | ---- | .82 | −2.2 | 6 | ---- | sw. | ---- | ---- | ---- | 12 | 11 | 8 | ---- | .0 | .0 |
| Marquette | 734 | 77 | 111 | 29.15 | 29.95 | −.02 | 54.2 | +5.2 | 99 | 31 | 66 | 34 | 11 | 42 | 55 | 45 | 39 | 62 | .60 | −2.4 | 7 | 8,030 | sw. | 44 | s. | 9 | 8 | 9 | 14 | 6.3 | T | .0 |
| Sault Sainte Marie | 614 | 11 | 52 | 29.29 | 29.99 | +.04 | 50.8 | +1.8 | 82 | 3 | 62 | 28 | 12 | 39 | 39 | 44 | 37 | 64 | 1.50 | −1.5 | 14 | 6,671 | nw. | 33 | nw. | 10 | 10 | 11 | 10 | 5.2 | T | .0 |
| Chicago | 673 | 7 | 131 | 29.29 | 30.01 | +.05 | 65.2 | +7.7 | 98 | 31 | 77 | 43 | 12 | 54 | 38 | 52 | 43 | 50 | .67 | −2.9 | 5 | 7,819 | sw. | 30 | sw. | 9 | 16 | 7 | 8 | 4.1 | .0 | .0 |
| Green Bay | 617 | 109 | 141 | 29.30 | 29.95 | .00 | 61.3 | +6.4 | 99 | 31 | 74 | 32 | 12 | 48 | 46 | 51 | 43 | 55 | 2.01 | −1.5 | 9 | 8,606 | s. | 36 | s. | 16 | 9 | 11 | 11 | 5.6 | .0 | .0 |
| Milwaukee | 681 | 97 | 221 | 29.26 | 29.99 | +.03 | 60.6 | +6.5 | 93 | 9 | 72 | 36 | 12 | 49 | 48 | 51 | 42 | 53 | 2.73 | −.6 | 5 | 9,519 | sw. | 40 | sw. | 9 | 12 | 12 | 7 | 4.1 | .0 | .0 |
| Duluth | 1,133 | 5 | 47 | 28.70 | 29.92 | −.04 | 53.0 | +5.7 | 91 | 28 | 65 | 32 | 15 | 41 | 46 | 45 | 38 | 62 | 1.10 | −2.2 | 9 | 9,567 | ne. | 46 | nw. | 10 | 10 | 13 | 8 | 4.8 | .0 | .0 |
| *North Dakota* | | | | | | | 63.6 | +9.6 | | | | | | | | | | 42 | 0.56 | −1.8 | | | | | | | | | 4.8 | | |
| Moorhead, Minn | 940 | 50 | 58 | 28.86 | 29.86 | −.08 | 63.6 | +8.5 | 104 | 30 | 78 | 30 | 11 | 49 | 50 | 51 | 39 | 45 | 1.15 | −1.7 | 11 | 7,576 | s. | 30 | se. | 19 | 9 | 14 | 8 | 5.5 | .0 | .0 |
| Bismarck | 1,674 | 8 | 57 | 28.11 | 29.86 | −.06 | 65.6 | +11.1 | 102 | 30 | 81 | 34 | 22 | 51 | 44 | 51 | 37 | 40 | .09 | −2.2 | 3 | 7,842 | nw. | 38 | nw. | 9 | 10 | 13 | 8 | 5.0 | .0 | .0 |
| Devils Lake | 1,478 | 11 | 44 | 28.32 | 29.88 | −.06 | 61.3 | +8.7 | 106 | 30 | 76 | 28 | 11 | 46 | 50 | 48 | 35 | 43 | .68 | −1.4 | 8 | 8,372 | se. | 34 | nw. | 9 | 10 | 12 | 9 | 5.6 | .0 | .0 |
| Grand Forks | 833 | 12 | 67 | ---- | ---- | ---- | 62.0 | ---- | 105 | 30 | 78 | 24 | 11 | 46 | 55 | 50 | ---- | ---- | .90 | ---- | 6 | ---- | nw. | 39 | nw. | 9 | 8 | 20 | 3 | ---- | .0 | .0 |
| Williston | 1,878 | 41 | 48 | 27.92 | 29.87 | −.06 | 64.1 | +10.1 | 99 | 29 | 78 | 30 | 13 | 50 | 42 | 49 | 35 | 40 | .33 | −1.7 | 3 | 7,155 | w. | 39 | nw. | 8 | 18 | 10 | 3 | 3.1 | .0 | .0 |
| *Upper Mississippi Valley* | | | | | | | 69.3 | +7.7 | | | | | | | | | | 47 | 0.78 | −3.3 | | | | | | | | | 3.6 | | |
| Minneapolis | 918 | 102 | 208 | 28.93 | 29.89 | ---- | 68.7 | +11.0 | 106 | 31 | 81 | 40 | 11 | 56 | 42 | 53 | 38 | 37 | .21 | −3.5 | 5 | 8,766 | s. | 44 | nw. | 9 | 8 | 16 | 7 | 5.1 | .0 | .0 |
| La Crosse | 714 | 11 | 48 | 29.16 | 29.91 | −.03 | 68.0 | +8.7 | 107 | 31 | 82 | 39 | 25 | 54 | 45 | 54 | 44 | 47 | .91 | −2.8 | 4 | 4,554 | s. | 21 | w. | 10 | 14 | 11 | 6 | 4.3 | .0 | .0 |
| Madison | 974 | 70 | 78 | 28.93 | 29.96 | .00 | 65.7 | +8.1 | 101 | 31 | 78 | 35 | 12 | 53 | 39 | 53 | 42 | 46 | .82 | −3.0 | 5 | 6,881 | s. | 30 | w. | 10 | 17 | 8 | 6 | 3.8 | .0 | .0 |
| Charles City | 1,015 | 10 | 51 | 28.88 | 29.93 | −.01 | 68.0 | +10.2 | 104 | 31 | 83 | 37 | 15 | 53 | 44 | 54 | 41 | 41 | .54 | −3.8 | 5 | 6,457 | se. | 32 | se. | 12 | 23 | 5 | 3 | 2.6 | .0 | .0 |
| Davenport | 606 | 66 | 161 | 29.34 | 29.99 | +.04 | 70.2 | +8.9 | 103 | 31 | 82 | 46 | 12 | 58 | 35 | 56 | 44 | 45 | .81 | −3.1 | 5 | 7,285 | sw. | 40 | sw. | 12 | 16 | 10 | 5 | 3.7 | .0 | .0 |
| Des Moines | 861 | 5 | 99 | 29.06 | 29.94 | +.01 | 71.1 | +9.8 | 105 | 30 | 84 | 41 | 25 | 58 | 38 | 56 | 45 | 44 | 1.06 | −3.5 | 5 | 7,884 | s. | 35 | w. | 9 | 18 | 9 | 4 | 3.2 | .0 | .0 |
| Dubuque | 700 | 60 | 79 | 29.22 | 29.96 | +.01 | 69.0 | +8.7 | 104 | 31 | 82 | 41 | 25 | 56 | 36 | 54 | 42 | 43 | .76 | −3.5 | 6 | 5,003 | s. | 24 | nw. | 10 | 18 | 5 | 8 | 4.0 | .0 | .0 |
| Keokuk | 614 | 64 | 78 | 29.34 | 30.01 | +.07 | 70.0 | +6.2 | 102 | 31 | 81 | 47 | 25 | 59 | 32 | 58 | 49 | 51 | 1.34 | −2.6 | 8 | 5,523 | s. | 24 | nw. | 10 | 19 | 7 | 5 | 3.3 | .0 | .0 |
| Cairo | 358 | 87 | 93 | 29.62 | 29.99 | +.03 | 70.9 | +2.5 | 94 | 31 | 81 | 46 | 25 | 61 | 30 | 60 | 54 | 60 | 1.59 | −2.1 | 6 | 5,388 | n. | 23 | n. | 24 | 11 | 12 | 8 | 4.9 | .0 | .0 |
| Peoria | 609 | 11 | 45 | 29.35 | 30.02 | +.06 | 68.7 | +7.0 | 104 | 31 | 83 | 38 | 25 | 55 | 45 | 56 | 47 | 51 | .47 | −3.6 | 4 | 5,055 | s. | 21 | nw. | 10 | 24 | 3 | 4 | 2.1 | .0 | .0 |
| Springfield, Ill | 636 | 5 | 191 | 29.33 | 30.00 | +.05 | 69.7 | +6.5 | 101 | 31 | 82 | 42 | 16 | 57 | 38 | 56 | 46 | 48 | .32 | −4.1 | 5 | 8,067 | s. | 29 | n. | 21 | 18 | 9 | 4 | 3.4 | .0 | .0 |
| St. Louis | 568 | 265 | 303 | 29.40 | 29.99 | +.04 | 71.2 | +4.3 | 96 | 30 | 82 | 47 | 25 | 61 | 28 | 58 | 49 | 51 | .54 | −3.8 | 2 | 8,358 | s. | 30 | s. | 9 | 21 | 7 | 3 | 2.6 | .0 | .0 |
| *Missouri Valley* | | | | | | | 70.2 | +8.1 | | | | | | | | | | 47 | 2.23 | −1.9 | | | | | | | | | 3.2 | | |
| Columbia, Mo | 784 | 6 | 84 | 29.18 | 30.00 | +.06 | 68.8 | +4.5 | 101 | 31 | 82 | 42 | 26 | 56 | 37 | ---- | ---- | ---- | 1.35 | −3.1 | 6 | 5,211 | s. | 22 | s. | 12 | 17 | 12 | 2 | 2.9 | 0.0 | 0.0 |
| Kansas City | 750 | 32 | 45 | 29.18 | 29.97 | +.05 | 71.0 | +6.2 | 103 | 30 | 83 | 46 | 26 | 59 | 35 | 59 | 52 | 56 | 3.14 | −1.5 | 7 | 6,822 | sw. | 40 | n. | 21 | 17 | 9 | 5 | 3.7 | .0 | .0 |
| St. Joseph | 967 | 11 | 49 | 28.95 | 29.97 | ---- | 70.8 | ---- | 103 | 30 | 83 | 45 | 25 | 58 | 34 | 58 | 49 | 53 | 2.34 | −1.9 | 7 | 5,822 | sw. | 31 | w. | 4 | 21 | 6 | 4 | 2.6 | .0 | .0 |
| Springfield, Mo | 1,324 | 98 | 104 | 28.61 | 30.00 | +.07 | 68.2 | +3.7 | 95 | 31 | 79 | 47 | 25 | 58 | 28 | 58 | 51 | 59 | 2.07 | −3.1 | 8 | 6,390 | s. | 32 | se. | 21 | 20 | 8 | 3 | 2.5 | .0 | .0 |
| Iola | 984 | 11 | 50 | 28.95 | 29.98 | +.06 | 68.4 | +3.2 | 98 | 31 | 82 | 45 | 16 | 55 | 36 | ---- | ---- | ---- | 5.74 | +1.0 | 6 | ---- | s. | ---- | ---- | ---- | 16 | 9 | 6 | ---- | .0 | .0 |
| Topeka | 987 | 65 | 87 | ---- | ---- | ---- | 70.4 | +6.1 | 103 | 30 | 84 | 48 | 25 | 57 | 36 | ---- | ---- | ---- | 6.47 | +2.0 | 7 | 6,700 | s. | 28 | sw. | 12 | 20 | 6 | 5 | 2.9 | .0 | .0 |
| Lincoln | 1,189 | 11 | 81 | 28.68 | 29.92 | +.01 | 71.9 | +10.2 | 104 | 30 | 86 | 49 | 14 | 60 | 33 | 56 | 43 | 41 | .60 | −3.2 | 2 | 9,343 | s. | 37 | n. | 21 | 20 | 7 | 4 | 2.9 | .0 | .0 |
| Omaha | 1,105 | 170 | 220 | 28.78 | 29.94 | +.02 | 72.9 | +10.5 | 103 | 30 | 86 | 49 | 14 | 60 | 33 | 56 | 43 | 41 | .60 | −3.2 | 2 | 9,343 | s. | 37 | n. | 21 | 20 | 7 | 4 | 2.9 | .0 | .0 |
| Valentine | 2,598 | 47 | 54 | 27.24 | 29.90 | .00 | 67.4 | +11.2 | 102 | 29 | 83 | 35 | 14 | 52 | 43 | 53 | 41 | 44 | 1.03 | −1.8 | 5 | 8,023 | s. | 32 | nw. | 31 | 15 | 12 | 4 | 4.1 | .0 | .0 |
| Sioux City | 1,138 | 64 | 106 | 28.70 | 29.89 | −.03 | 72.6 | +12.2 | 105 | 30 | 86 | 39 | 25 | 59 | 40 | 56 | 43 | 40 | .60 | −3.4 | 4 | 8,628 | s. | 32 | nw. | 9 | 17 | 10 | 4 | 3.9 | .0 | .0 |
| Huron | 1,306 | 60 | 74 | 28.50 | 29.86 | −.06 | 70.0 | +13.6 | 106 | 30 | 86 | 38 | 24 | 54 | 46 | 54 | 38 | 37 | .65 | −2.3 | 3 | 8,317 | s. | 33 | nw. | 31 | 25 | 4 | 2 | 2.5 | .0 | .0 |
| *Northern Slope* | | | | | | | 61.9 | +9.1 | | | | | | | | | | 46 | .71 | −01.7 | | | | | | | | | 4.7 | | |
| Billings | 3,140 | 4 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- |
| Havre | 2,505 | 11 | 67 | 27.31 | 29.91 | +.01 | 62.5 | +9.1 | 95 | 29 | 77 | 34 | 13 | 48 | 43 | 49 | 37 | 46 | .58 | −1.5 | 10 | 7,466 | sw. | 37 | sw. | 20 | 13 | 16 | 2 | 4.0 | .0 | .0 |
| Helena | 4,124 | 85 | 111 | 25.77 | 29.91 | −.02 | 59.6 | +8.0 | 89 | 25 | 73 | 31 | 13 | 48 | 39 | 47 | 37 | 47 | .34 | −2.0 | 9 | 6,434 | sw. | 48 | s. | 25 | 4 | 17 | 10 | 6.1 | T | .0 |
| Kalispell | 2,973 | 48 | 56 | 26.92 | 29.94 | +.06 | 57.2 | +5.8 | 89 | 24 | 70 | 33 | 21 | 45 | 39 | 48 | 39 | 58 | 1.22 | −.2 | 8 | 5,061 | w. | 23 | w. | 26 | 7 | 18 | 6 | 5.5 | .0 | .0 |
| Miles City | 2,371 | 48 | 55 | 27.41 | 29.91 | .00 | 66.9 | +10.2 | 101 | 29 | 81 | 32 | 13 | 52 | 43 | 50 | 34 | 36 | .34 | −1.9 | 2 | 5,213 | s. | 30 | s. | 8 | 17 | 13 | 1 | 3.5 | .0 | .0 |
| Rapid City | 3,259 | 50 | 58 | 26.57 | 29.91 | +.01 | 66.6 | +12.6 | 97 | 27 | 81 | 32 | 13 | 52 | 42 | 52 | 38 | 39 | .44 | −3.1 | 4 | 6,727 | n. | 27 | w. | 7 | 13 | 15 | 3 | 3.9 | .0 | .0 |
| Cheyenne | 6,094 | 50 | 71 | 24.04 | 29.90 | +.05 | 59.2 | +8.9 | 86 | 28 | 73 | 29 | 13 | 46 | 37 | 46 | 35 | 47 | 1.66 | −.8 | 10 | 6,934 | w. | 29 | nw. | 8 | 8 | 14 | 9 | 5.7 | 2.3 | .0 |
| Lander | 5,372 | 60 | 68 | 24.65 | 29.90 | +.02 | 61.2 | +10.9 | 87 | 27 | 77 | 32 | 13 | 46 | 40 | 46 | 33 | 43 | .92 | −1.3 | 3 | 4,322 | sw. | 29 | sw. | 8 | 17 | 12 | 2 | 3.4 | 3.5 | .0 |
| Sheridan | 3,790 | 10 | 47 | 26.07 | 29.91 | ---- | 61.4 | ---- | 94 | 26 | 79 | 30 | 13 | 44 | 49 | 49 | 37 | 48 | .53 | −2.1 | 3 | 3,890 | nw. | 21 | sw. | 8 | 13 | 16 | 2 | 3.8 | .0 | .0 |
| Yellowstone Park | 6,241 | 11 | 48 | 23.92 | 29.94 | +.03 | 54.7 | +7.3 | 82 | 28 | 70 | 22 | 13 | 40 | 41 | 42 | 31 | 48 | .42 | −1.8 | 5 | 6,793 | sw. | 30 | sw. | 8 | 6 | 16 | 9 | 5.9 | T | .0 |
| North Platte | 2,821 | 11 | 51 | 27.02 | 29.89 | +.01 | 68.9 | +10.2 | 99 | 8 | 83 | 40 | 10 | 54 | 42 | 55 | 46 | 53 | .65 | −2.1 | 7 | 6,530 | s. | 27 | s. | 1 | 10 | 14 | 7 | 5.2 | .0 | .0 |

TABLE 1.—*Climatological data for Weather Bureau stations, May 1934*—Continued

| District and station | Elevation of instruments: Barometer above sea level | Thermometer above ground | Anemometer above ground | Pressure: Station, reduced to mean of 24 hours | Sea level, reduced to mean of 24 hours | Departure from normal | Temperature of the air: Mean max.+mean min.÷2 | Departure from normal | Maximum | Date | Mean maximum | Minimum | Date | Mean minimum | Greatest daily range | Mean wet thermometer | Mean temperature of the dew-point | Mean relative humidity | Precipitation: Total | Departure from normal | Days with 0.01 or more | Wind: Total movement | Prevailing direction | Maximum velocity: Miles per hour | Direction | Date | Clear days | Partly cloudy days | Cloudy days | Average cloudiness, tenths | Total snowfall | Snow, sleet, and ice on ground at end of month |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ft. | Ft. | Ft. | In. | In. | In. | °F. | °F. | °F. | | °F. | °F. | | °F. | °F. | °F. | °F. | % | In. | In. | | Miles | | | | | | | | 0–10 | In. | In. |
| *Middle Slope* | | | | | | | 68.6 | +6.1 | | | | | | | | | | 52 | 2.22 | −1.1 | | | | | | | | | | 4.6 | | |
| Denver | 5,292 | 106 | 113 | 24.74 | 29.90 | +0.06 | 64.6 | +8.4 | 88 | 18 | 77 | 32 | 13 | 52 | 36 | 49 | 36 | 41 | 1.58 | −0.6 | 10 | 6,068 | s. | 27 | se. | 29 | 7 | 14 | 10 | 5.7 | 1.0 | 0.0 |
| Pueblo | 4,685 | 80 | 86 | 25.29 | 29.89 | +.06 | 67.0 | +7.8 | 93 | 28 | 83 | 37 | 14 | 52 | 46 | 49 | 35 | 40 | .47 | −1.1 | 5 | 5,725 | nw. | 30 | sw. | 30 | 6 | 22 | 3 | 5.2 | .0 | .0 |
| Concordia | 1,392 | 50 | 58 | 28.52 | 29.97 | +.06 | 70.5 | +7.3 | 101 | 30 | 82 | 46 | 15 | 58 | 37 | 58 | 50 | 56 | 2.55 | −1.6 | 9 | 7,082 | s. | 28 | ne. | 21 | 15 | 9 | 7 | 3.9 | .0 | .0 |
| Dodge City | 2,509 | 10 | 86 | 27.39 | 29.95 | +.08 | 69.5 | +6.0 | 98 | 28 | 83 | 41 | 15 | 56 | 39 | 55 | 46 | 52 | 1.00 | −1.9 | 8 | 10,333 | s. | 35 | s. | 1 | 17 | 8 | 6 | 3.8 | .0 | .0 |
| Wichita | 1,358 | 85 | 93 | 28.54 | 29.96 | +.06 | 69.2 | +4.1 | 100 | 31 | 80 | 47 | 14 | 59 | 33 | 58 | 51 | 58 | 4.14 | −.3 | 8 | 8,242 | sw. | 33 | sw. | 12 | 17 | 5 | 9 | 4.2 | .0 | .0 |
| Oklahoma City | 1,214 | 10 | 47 | 28.70 | 29.95 | +.06 | 70.9 | +3.2 | 98 | 31 | 82 | 48 | 16 | 60 | 32 | 60 | 55 | 64 | 3.61 | −1.3 | 7 | 6,799 | s. | 24 | se. | 2 | 12 | 9 | 10 | 5.1 | .0 | .0 |
| *Southern Slope* | | | | | | | 73.4 | +2.8 | | | | | | | | | | 51 | 1.83 | −0.8 | | | | | | | | | | 3.8 | | |
| Abilene | 1,738 | 10 | 52 | 28.15 | 29.92 | +.05 | 74.7 | +2.7 | 101 | 29 | 88 | 45 | 16 | 62 | 41 | 60 | 52 | 56 | 1.45 | −2.5 | 5 | 7,013 | s. | 25 | s. | 1 | 19 | 5 | 7 | 3.7 | .0 | .0 |
| Amarillo | 3,676 | 10 | 49 | 26.27 | 29.93 | +.09 | 68.9 | +4.8 | 94 | 17 | 82 | 40 | 14 | 56 | 40 | 55 | 46 | 54 | 3.21 | +.4 | 10 | 7,657 | s. | 32 | sw. | 2 | 12 | 15 | 4 | 4.1 | .0 | .0 |
| Big Spring | 2,537 | 5 | 62 | 27.34 | 29.91 | ----- | 74.0 | ----- | 99 | 21 | 87 | 44 | 15 | 61 | 40 | 59 | 50 | 52 | .20 | ----- | 3 | ----- | s. | ----- | ----- | ----- | 17 | 9 | 5 | 3.5 | .0 | .0 |
| Del Rio | 944 | 64 | 71 | 28.89 | 29.85 | .00 | 78.6 | +1.6 | 102 | 6 | 90 | 55 | 16 | 67 | 33 | 64 | 55 | 53 | 1.77 | −1.1 | 7 | 7,133 | se. | 29 | se. | 22 | 12 | 15 | 4 | 4.1 | .0 | .0 |
| Roswell | 3,566 | 75 | 85 | 26.33 | 29.87 | +.05 | 71.4 | +2.0 | 98 | 29 | 86 | 45 | 3 | 56 | 43 | 54 | 40 | 40 | .89 | −.2 | 6 | 6,758 | s. | 35 | nw. | 12 | 12 | 17 | 2 | 3.8 | .0 | .0 |
| *Southern Plateau* | | | | | | | 71.2 | +5.8 | | | | | | | | | | 36 | 0.63 | +0.3 | | | | | | | | | | 3.1 | | |
| El Paso | 3,778 | 152 | 175 | 26.14 | 29.82 | +.04 | 76.8 | +5.3 | 98 | 29 | 90 | 51 | 3 | 64 | 37 | 55 | 37 | 29 | .37 | .0 | 2 | 7,815 | e. | 45 | nw. | 22 | 22 | 8 | 1 | 2.2 | .0 | .0 |
| Albuquerque | 4,972 | 5 | 39 | 25.04 | 29.82 | ----- | 67.1 | ----- | 92 | 29 | 83 | 40 | 3 | 51 | 43 | 51 | 39 | 44 | .72 | ----- | 5 | 7,307 | n. | 41 | w. | 2 | 10 | 14 | 7 | 4.9 | .0 | .0 |
| Santa Fe | 7,013 | 38 | 53 | 23.30 | 29.86 | +.05 | 61.0 | +5.3 | 83 | 9 | 74 | 34 | 3 | 48 | 36 | 46 | 34 | 45 | 2.67 | +1.4 | 6 | 5,081 | e. | 24 | s. | 13 | 11 | 14 | 6 | 4.7 | .0 | .0 |
| Flagstaff | 6,907 | 10 | 59 | 23.37 | 29.83 | +.05 | 55.6 | +4.9 | 82 | 10 | 72 | 30 | 15 | 39 | 46 | 42 | ----- | 43 | 1.41 | ----- | 5 | 6,696 | sw. | 35 | sw. | 1 | 12 | 13 | 6 | ----- | T | .0 |
| Phoenix | 1,108 | 10 | 107 | 28.65 | 29.77 | −.01 | 83.2 | +8.2 | 111 | 10 | 99 | 54 | 2 | 68 | 40 | 57 | 34 | 23 | .10 | .0 | 2 | 4,744 | e. | 28 | sw. | 27 | 21 | 6 | 4 | 2.7 | .0 | .0 |
| Yuma | 141 | 9 | 54 | 29.63 | 29.77 | −.02 | 81.8 | +5.6 | 112 | 11 | 99 | 55 | 2 | 64 | 43 | 60 | 43 | 33 | .00 | .0 | 0 | 4,518 | w. | 30 | w. | 1 | 28 | 3 | 0 | .8 | .0 | .0 |
| Independence | 3,957 | 5 | 26 | 25.91 | 29.88 | +.04 | 68.7 | +5.7 | 94 | 10 | 84 | 42 | 26 | 53 | 38 | 49 | ----- | ----- | .03 | −.1 | 1 | ----- | s. | ----- | ----- | ----- | 19 | 7 | 5 | ----- | .0 | .0 |
| *Middle Plateau* | | | | | | | 63.9 | +8.0 | | | | | | | | | | 34 | 0.67 | −0.3 | | | | | | | | | | 3.6 | | |
| Reno | 4,527 | 61 | 76 | 25.45 | 29.90 | −.01 | 60.2 | +6.6 | 88 | 10 | 75 | 35 | 2 | 45 | 41 | 46 | 35 | 47 | 1.35 | +.7 | 2 | 5,939 | w. | 31 | w. | 31 | 14 | 13 | 4 | 3.8 | 0.0 | 0.0 |
| Tonopah | 6,090 | 12 | 20 | ----- | ----- | ----- | 62.2 | ----- | 85 | 11 | 74 | 34 | 1 | 50 | 40 | 44 | 25 | 28 | T | ----- | 0 | ----- | se. | ----- | ----- | ----- | ----- | ----- | ----- | ----- | .0 | .0 |
| Winnemucca | 4,344 | 18 | 56 | 25.57 | 29.90 | −.01 | 61.7 | +7.8 | 92 | 22 | 78 | 32 | 2 | 45 | 49 | 45 | 28 | 36 | .23 | −.6 | 1 | 5,985 | sw. | 30 | nw. | 31 | 16 | 13 | 2 | 3.2 | .0 | .0 |
| Modena | 5,473 | 10 | 46 | 24.58 | 29.83 | +.01 | 60.6 | +7.1 | 90 | 11 | 79 | 31 | 3 | 42 | 45 | 42 | 20 | 25 | .28 | −.5 | 1 | 8,417 | sw. | 37 | sw. | 31 | 19 | 5 | 7 | 3.3 | .3 | .0 |
| Salt Lake City | 4,360 | 86 | 210 | 25.56 | 29.85 | −.01 | 68.2 | +10.8 | 90 | 6 | 81 | 38 | 2 | 55 | 36 | 49 | 32 | 29 | .01 | −1.9 | 1 | 6,493 | s. | 31 | se. | 1 | 18 | 8 | 5 | 3.6 | .0 | .0 |
| Grand Junction | 4,602 | 60 | 68 | 25.35 | 29.88 | +.05 | 68.9 | +7.8 | 91 | 21 | 82 | 43 | 14 | 55 | 36 | 50 | 35 | 38 | 1.48 | +.7 | 5 | 5,532 | se. | 30 | w. | 29 | 15 | 9 | 7 | 4.0 | .0 | .0 |
| *Northern Plateau* | | | | | | | 62.6 | +6.5 | | | | | | | | | | 44 | 0.24 | −1.1 | | | | | | | | | | 5.2 | | |
| Baker | 3,471 | 48 | 53 | 26.43 | 29.98 | +.02 | 58.0 | +6.3 | 89 | 27 | 73 | 30 | 9 | 43 | 49 | 46 | 35 | 49 | .45 | −1.1 | 4 | 5,187 | n. | 21 | sw. | 7 | 7 | 21 | 3 | 5.1 | .0 | .0 |
| Boise | 2,739 | 79 | 87 | 27.09 | 29.91 | −.03 | 65.4 | +8.3 | 93 | 23 | 80 | 36 | 9 | 51 | 39 | 50 | 36 | 40 | .10 | −1.3 | 4 | 4,580 | nw. | 28 | se. | 28 | 10 | 13 | 8 | 5.0 | .0 | .0 |
| Pocatello | 4,477 | 60 | 68 | 25.44 | 29.88 | −.01 | 63.2 | +9.4 | 88 | 22 | 78 | 34 | 2 | 48 | 43 | 46 | 29 | 34 | T | −1.5 | 0 | 6,509 | se. | 24 | sw. | 20 | 13 | 13 | 5 | 4.4 | .0 | .0 |
| Spokane | 1,929 | 101 | 110 | 27.92 | 29.95 | −.01 | 61.2 | +5.7 | 96 | 28 | 74 | 38 | 21 | 49 | 38 | 49 | 38 | 48 | .25 | −1.2 | 5 | 5,442 | s. | 24 | sw. | 30 | 5 | 15 | 11 | 6.2 | .0 | .0 |
| Walla Walla | 991 | 57 | 65 | 28.89 | 29.95 | −.01 | 64.6 | +5.0 | 99 | 28 | 77 | 43 | 21 | 53 | 40 | 52 | 40 | 46 | .41 | −1.2 | 5 | 4,531 | s. | 21 | w. | 19 | 10 | 12 | 9 | 5.2 | .0 | .0 |
| Yakima | 1,076 | 58 | 67 | 28.83 | 29.97 | ----- | 63.4 | +4.4 | 100 | 28 | 77 | 38 | 9 | 50 | 39 | 51 | 39 | 48 | .20 | −.4 | 3 | 5,432 | nw. | 26 | sw. | 4 | 12 | 6 | 13 | 5.3 | .0 | .0 |
| *North Pacific Coast Region* | | | | | | | 58.3 | +4.7 | | | | | | | | | | 71 | 2.64 | +0.3 | | | | | | | | | | 6.8 | | |
| North Head | 211 | 11 | 56 | 29.81 | 30.04 | +.01 | 55.4 | +4.5 | 83 | 13 | 60 | 46 | 3 | 51 | 28 | 52 | 49 | 82 | 4.37 | +1.4 | 15 | 10,743 | n. | 56 | s. | 4 | 6 | 10 | 15 | 6.7 | .0 | .0 |
| Seattle | 125 | 90 | 321 | 29.88 | 30.01 | .00 | 58.8 | +4.3 | 92 | 13 | 67 | 45 | 9 | 51 | 38 | 51 | 45 | 65 | 2.48 | +.6 | 13 | 6,610 | se. | 28 | w. | 5 | 7 | 9 | 15 | 6.4 | .0 | .0 |
| Tatoosh Island | 86 | 10 | 54 | 29.93 | 30.02 | +.01 | 54.1 | +4.5 | 81 | 13 | 58 | 45 | 4 | 50 | 27 | 50 | 48 | 83 | 5.20 | +1.2 | 15 | 9,627 | w. | 56 | s. | 4 | 5 | 5 | 21 | 7.4 | .0 | .0 |
| Medford | 1,329 | 29 | 58 | 28.57 | 29.97 | ----- | 60.9 | ----- | 93 | 13 | 74 | 36 | 1 | 48 | 47 | 52 | 44 | 62 | .99 | −.2 | 11 | 5,195 | nw. | 25 | se. | 28 | 5 | 8 | 18 | 6.8 | .0 | .0 |
| Portland, Oreg. | 153 | 68 | 106 | 29.86 | 30.02 | −.01 | 61.4 | +4.5 | 90 | 22 | 71 | 43 | 20 | 52 | 34 | 54 | 48 | 67 | 1.60 | −.6 | 14 | 4,836 | nw. | 18 | ne. | 13 | 6 | 5 | 20 | 7.0 | .0 | .0 |
| Roseburg | 510 | 45 | 76 | 29.47 | 30.02 | −.01 | 61.6 | +5.6 | 95 | 13 | 74 | 39 | 9 | 50 | 48 | 54 | 48 | 69 | 1.21 | −.7 | 11 | 3,605 | n. | 21 | sw. | 4 | 4 | 11 | 16 | 6.8 | .0 | .0 |
| *Middle Pacific Coast Region* | | | | | | | 64.0 | +4.4 | | | | | | | | | | 68 | 0.64 | −0.5 | | | | | | | | | | 4.2 | | |
| Eureka | 62 | 73 | 89 | 29.99 | 30.06 | +.01 | 56.8 | +4.8 | 70 | 4 | 62 | 45 | 9 | 52 | 17 | 53 | 51 | 85 | 1.23 | −.6 | 11 | 5,651 | n. | 24 | sw. | 4 | 11 | 8 | 12 | 5.6 | .0 | .0 |
| Red Bluff | 330 | 5 | 58 | 29.57 | 29.92 | −.03 | 70.2 | +3.9 | 100 | 21 | 84 | 46 | 1 | 57 | 39 | 58 | 48 | 54 | .96 | −.2 | 8 | 4,335 | n. | 18 | n. | 12 | 13 | 9 | 9 | 4.8 | .0 | .0 |
| Sacramento | 66 | 87 | 115 | 29.85 | 29.92 | −.02 | 68.2 | +4.9 | 98 | 11 | 82 | 45 | 1 | 54 | 41 | 57 | 48 | 58 | .26 | −.5 | 3 | 6,017 | s. | 21 | s. | 31 | 23 | 7 | 1 | 2.2 | .0 | .0 |
| San Francisco | 155 | 208 | 243 | 29.81 | 29.98 | −.01 | 60.6 | +3.8 | 87 | 11 | 68 | 50 | 1 | 54 | 31 | 54 | 50 | 74 | .12 | −.7 | 3 | 6,350 | w. | 29 | nw. | 31 | 14 | 10 | 7 | 4.3 | .0 | .0 |
| *South Pacific Coast Region* | | | | | | | 67.8 | +4.5 | | | | | | | | | | 64 | 0.02 | −0.4 | | | | | | | | | | 3.6 | | |
| Fresno | 327 | 97 | 105 | 29.56 | 29.91 | −.01 | 71.3 | +4.2 | 100 | 11 | 86 | 48 | 2 | 57 | 39 | 56 | 43 | 44 | .03 | −.4 | 1 | 5,889 | nw. | 25 | w. | 22 | 18 | 7 | 6 | 3.3 | .0 | .0 |
| Los Angeles | 338 | 159 | 191 | 29.57 | 29.93 | −.02 | 67.5 | +5.3 | 95 | 10 | 77 | 53 | 2 | 58 | 29 | 59 | 54 | 70 | .00 | −.4 | 0 | 4,339 | sw. | 18 | w. | 1 | 18 | 13 | 0 | 3.3 | .0 | .0 |
| San Diego | 87 | 62 | 70 | 29.84 | 29.93 | −.02 | 64.7 | +3.9 | 83 | 10 | 70 | 54 | 3 | 59 | 21 | 59 | 57 | 79 | .02 | −.3 | 1 | 5,173 | sw. | 20 | w. | 1 | 17 | 10 | 4 | 4.1 | .0 | .0 |
| *West Indies* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| San Juan P.R. | 82 | 9 | 54 | 29.91 | 30.00 | ----- | 78.6 | .0 | 91 | 26 | 84 | 70 | 17 | 73 | 18 | ----- | ----- | ----- | 1.78 | −3.5 | 13 | 9,039 | e. | 30 | e. | 4 | 4 | 22 | 5 | 5.7 | .0 | .0 |
| *Panama Canal* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Balboa Heights | 118 | 6 | 97 | ----- | [1] 29.83 | +.01 | 80.4 | −.3 | 91 | 6 | 86 | 71 | 30 | 74 | 16 | ----- | ----- | [1] 86 | 4.96 | −2.9 | 19 | 3,777 | nw. | 19 | n. | 11 | 1 | 14 | 16 | 7.3 | .0 | .0 |
| Cristobal | 36 | 6 | 97 | ----- | [1] 29.84 | +.01 | 81.8 | +1.1 | 90 | 22 | 87 | 73 | 30 | 77 | 16 | 77 | 76 | [1] 84 | 11.94 | −.5 | 17 | 5,126 | n. | 20 | n. | 6 | 2 | 6 | 23 | 7.7 | .0 | .0 |
| *Alaska* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fairbanks | 454 | 11 | 87 | [2] 29.28 | [2] 29.79 | ----- | 45.4 | ----- | 72 | 21 | 56 | 27 | 10 | 35 | 34 | 38 | 29 | 58 | .22 | ----- | 7 | 5,311 | sw. | 32 | s. | 12 | 1 | 7 | 23 | 8.1 | .3 | .0 |
| Juneau | 80 | 96 | 116 | [2] 29.83 | [2] 29.92 | ----- | 49.2 | ----- | 71 | 22 | 57 | 35 | 10 | 42 | 30 | 44 | 38 | 68 | 2.75 | ----- | 17 | 5,343 | s. | 29 | se. | 19 | 6 | 4 | 21 | 7.5 | .0 | .0 |
| *Hawaiian Islands* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Honolulu | 38 | 86 | 100 | [2] 30.01 | [2] 30.05 | ----- | 75.0 | +.2 | 83 | 25 | 80 | 68 | 18 | 71 | 13 | 69 | 66 | 75 | .57 | −1.2 | 13 | 7,018 | e. | 24 | ne. | 12 | 14 | 14 | 3 | 3.9 | .0 | .0 |

[1] Observations taken hourly.

[2] Pressure not reduced to mean of 24 hours.

TABLE 2.—*Data furnished by the Canadian Meteorological Service*

MAY 1934

| Stations | Altitude above mean sea level, Jan. 1, 1919 | Pressure | | | Temperature of the air | | | | | | Precipitation | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Station reduced to mean of 24 hours | Sea level reduced to mean of 24 hours | Departure from normal | Mean max. + mean min. ÷2 | Departure from normal | Mean maximum | Mean minimum | Highest | Lowest | Total | Departure from normal | Total snowfall |
| | *Feet* | *In.* | *In.* | *In.* | *°F.* | *°F.* | *°F.* | *°F.* | *°F.* | *°F.* | *In.* | *In.* | *In.* |
| Cape Race, Newfoundland | 99 | | | | 40.7 | | 47.6 | 33.9 | 68 | 26 | 3.52 | | 0.6 |
| Sydney, Cape Breton Island | 48 | 29.91 | 29.96 | −0.01 | 48.4 | +3.2 | 59.3 | 37.5 | 80 | 26 | 3.04 | −0.73 | .0 |
| Halifax, Nova Scotia | 88 | 29.70 | 29.80 | −.18 | 50.4 | +2.0 | 59.4 | 41.4 | 78 | 31 | 3.03 | −1.23 | .0 |
| Yarmouth, Nova Scotia | 65 | 29.86 | 29.93 | −.05 | 49.8 | +2.2 | 57.8 | 41.8 | 67 | 32 | 1.68 | −1.89 | .0 |
| Charlottetown, Prince Edward Island | 38 | 29.85 | 29.89 | −.07 | 49.2 | +2.3 | 57.0 | 41.3 | 77 | 31 | 2.83 | −.08 | .0 |
| Chatham, New Brunswick | 28 | 29.78 | 29.81 | −.14 | 51.8 | +3.3 | 64.3 | 39.3 | 86 | 26 | 1.80 | −1.41 | .0 |
| Father Point, Quebec | 20 | 29.83 | 29.85 | −.08 | 46.1 | +2.1 | 54.3 | 37.9 | 72 | 38 | 1.86 | −.72 | .2 |
| Quebec, Quebec | 296 | 29.60 | 29.92 | −.02 | 53.7 | +3.8 | 64.2 | 43.3 | 79 | 32 | 2.75 | −.33 | .0 |
| Doucet, Quebec | 1,236 | | | | 45.3 | | 59.0 | 31.5 | 80 | 10 | 2.12 | | .9 |
| Montreal, Quebec | 187 | | | | | | | | | | | | |
| Ottawa, Ontario | 236 | 29.68 | 29.94 | .00 | 57.3 | +2.4 | 69.3 | 45.2 | 86 | 31 | 1.30 | −1.29 | .0 |
| Kingston, Ontario | 285 | 29.67 | 29.98 | +.02 | 53.6 | +.7 | 62.9 | 44.2 | 74 | 34 | 1.07 | −1.61 | .0 |
| Toronto, Ontario | 379 | 29.58 | 29.98 | .00 | 57.7 | +4.5 | 69.4 | 46.0 | 86 | 34 | .47 | −2.57 | .0 |
| Cochrane, Ontario | 930 | | | | 45.2 | | 59.2 | 31.1 | 81 | 23 | 2.59 | | 1.6 |
| White River, Ontario | 1,244 | 28.61 | 29.93 | −.02 | 47.1 | +1.4 | 61.8 | 32.4 | 79 | 21 | 1.20 | −.75 | .1 |
| London, Ontario | 808 | | | | 56.4 | | 69.9 | 42.8 | 86 | 27 | .98 | | .0 |
| Southampton, Ontario | 656 | 29.28 | 30.00 | +.04 | 49.8 | −.9 | 58.7 | 40.9 | 80 | 26 | 1.37 | −1.07 | .0 |
| Parry Sound, Ontario | 688 | 29.28 | 29.98 | +.03 | 53.1 | +2.0 | 64.5 | 41.7 | 78 | 29 | 1.71 | −1.22 | .0 |
| Port Arthur, Ontario | 644 | 29.20 | 29.91 | −.05 | 50.2 | +4.3 | 60.7 | 39.8 | 86 | 31 | 1.28 | −.87 | 2.9 |
| Winnipeg, Manitoba | 760 | 29.06 | 29.88 | −.08 | 56.2 | +4.6 | 69.6 | 42.9 | 100 | 18 | .63 | −1.65 | .0 |
| Minnedosa, Manitoba | 1,690 | 28.09 | 29.89 | −.07 | 54.7 | +6.3 | 69.8 | 39.6 | 91 | 20 | .48 | −.97 | .0 |
| Le Pas, Manitoba | 860 | | 29.93 | | 50.8 | | 62.0 | 39.7 | 85 | 22 | 2.10 | | .0 |
| Qu'Appelle, Saskatchewan | 2,115 | 27.61 | 29.83 | −.11 | 56.9 | +7.1 | 72.3 | 41.5 | 95 | 21 | .80 | −.85 | .0 |
| Moose Jaw, Saskatchewan | 1,759 | | | | 60.2 | | 75.8 | 44.7 | 100 | 29 | .63 | | .0 |
| Swift Current, Saskatchewan | 2,392 | 27.33 | 29.80 | −.12 | 60.7 | +10.0 | 75.7 | 45.8 | 98 | 30 | .39 | −1.37 | .0 |
| Medicine Hat, Alberta | 2,365 | 27.37 | 29.82 | −.07 | 60.9 | +6.8 | 74.5 | 47.4 | 97 | 33 | .46 | −.85 | .0 |
| Calgary, Alberta | 3,540 | 26.22 | 29.84 | −.04 | 55.3 | +6.3 | 68.9 | 41.7 | 87 | 32 | .60 | −1.17 | .4 |
| Banff, Alberta | 4,521 | 25.38 | 29.92 | +.04 | 50.1 | +3.1 | 64.4 | 35.8 | 85 | 27 | 1.72 | −.32 | .0 |
| Prince Albert, Saskatchewan | 1,450 | 28.34 | 29.90 | −.05 | 56.6 | +9.0 | 69.2 | 44.0 | 89 | 25 | .84 | −.42 | .1 |
| Battleford, Saskatchewan | 1,592 | 28.13 | 29.85 | −.07 | 57.9 | +6.9 | 72.8 | 43.1 | 90 | 28 | .83 | −.79 | .2 |
| Edmonton, Alberta | 2,150 | | | | | | | | | | | | |
| Kamloops, British Columbia | 1,262 | 28.65 | 29.93 | +.04 | 60.7 | +1.6 | 74.2 | 47.2 | 93 | 36 | .49 | −.75 | .0 |
| Victoria, British Columbia | 230 | 29.76 | 30.01 | +.01 | 54.8 | +2.3 | 61.5 | 48.1 | 76 | 41 | 1.22 | −.26 | .0 |
| Barkerville, British Columbia | 4,180 | | | | | | | | | | | | |
| Estevan Point, British Columbia | 20 | | | | 51.6 | | 56.7 | 46.6 | 72 | | 7.73 | | .0 |
| Prince Rupert, British Columbia | 170 | | | | 49.4 | | 55.9 | 42.9 | 72 | 37 | 5.80 | | .0 |
| Hamilton, Bermuda | 151 | 29.98 | 30.14 | +.08 | 72.3 | +2.9 | 77.1 | 67.5 | 82 | 61 | 3.60 | −1.06 | .0 |
| **LATE REPORTS FOR APRIL 1934** | | | | | | | | | | | | | |
| Banff, Alberta | 4,521 | 25.37 | 29.93 | +.03 | 44.8 | +9.5 | 59.4 | 30.2 | 78 | 15 | .94 | −.14 | 2.5 |

## SEVERE LOCAL STORMS, MAY 1934

(Compiled by Mary O. Souder)

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A revised list of tornadoes will appear in the Annual Report of the Chief of Bureau]

| Place | Date | Time | Width of path, yards | Loss of life | Value of property destroyed | Character of storm | Remarks | Authority |
|---|---|---|---|---|---|---|---|---|
| Sedan, Kans., and vicinity | 3 | 3 p.m. | 50 | | $1,000 | Tornado | Barn and small buildings damaged; storm accompanied by hail that was heavy in spots; poultry house collapsed killing 400 young chickens. | Official, U.S. Weather Bureau. |
| Wynne Wood, Okla. | 3 | 5:15 p.m. | 75–100 | | 150,000 | do | 10 homes completely demolished and many others considerably damaged; several persons slightly injured. | Do. |
| Winfield, Kans., 6 miles south | 4 | 2:30 p.m. | | | 500 | High wind | Residence and 2 chicken houses damaged; storm had characteristics of tornado; path narrow and 1 mile long. | Do. |
| Bartlesville, Okla., 7 miles east | 4 | do | | | 3,500 | Tornado | Hillsdale schoolhouse badly damaged; other damage principally to few rural homes and barns. | Do. |
| Paris, Tex. | 4 | do | | | 2,000 | Hail | Damage to greenhouses, roofs, and windows. | Do. |
| Tulsa, Okla., 10 miles southeast | 4 | 3 p.m. | 440 | 3 | 50,000 | Tornado | About 20 houses and number of farm buildings demolished; poultry and livestock lost; path 4 miles long. | Do. |
| Howden, Okla., to south of South Coffeyville, Kans. | 4 | 3:30 p.m. | 880 | 1 | 35,000 | do | Woman killed when her farm home was demolished; 12 others slightly injured; path 10 miles long. | Do. |
| Warrensburg and Valley City, Mo., vicinity of | 4 | 4 p.m. | | | | Rain and hail | Some hailstones as large as guinea eggs; considerable damage to all crops, especially gardens, some of which had to be made over; fields badly washed. | Do. |
| McCurtain County, Okla., extreme southeastern portion. | 4 | do | 1 2 | | 50,000 | Hail | Some damage to buildings; severe loss to crops; all gardens in path of storm practically destroyed; path 15 miles long. | Do. |
| Oklahoma to 2 miles southeast of Coffeyville, Kans. | 4 | 4:30 p.m. | 1,320 | 1 | 4,800 | Tornado | Telephone lines down; 2 motor cars wrecked; several farm buildings and an old highway bridge demolished; 5 persons injured; path 5 miles long. Additional damage in Oklahoma. | Do. |

## SEVERE LOCAL STORMS, MAY 1934—Continued

| Place | Date | Time | Width of path, yards | Loss of life | Value of property destroyed | Character of storm | Remarks | Authority |
|---|---|---|---|---|---|---|---|---|
| Frost, Tex. | 4 | 6 p.m. | | | | Hail | $1,500 damage to crops; other damage to roofs and windows. | Official U. S. Weather Bureau. |
| Dawson, Tex. | 4 | 7 p.m. | 1 10 | | 10,000 | Wind and hail | Damage to crops; church, numerous outbuildings and cotton gin destroyed. | Do. |
| Wortham, Tex. | 4 | do. | 880 | | 8,500 | Wind | $1,000 damage to crops, $7,500 to buildings. | Do. |
| Malakoff, Tex. | 4 | 8:30 p.m. | 440 | | 2,000 | Wind and rain | Damage to buildings; considerable loss to crops. | Do. |
| McCurtain County, Okla., northern portion. | 4 | P.m. | 200 | | 3,000 | Tornado | Much timber blown down. | Do. |
| Atlanta, Ark. | 4 | | | | 1,200 | Heavy hail | Severe loss to crops and damage to buildings. | Do. |
| Little River County, Ark., southern half. | 4 | | | | 50,000 | Wind and hail | 15 persons injured; loss to crops; buildings damaged. | Do. |
| McNeil, Ark. | 4 | | | | 1,000 | Wind | Damage to buildings. | Do. |
| Stamps, Ark. | 4 | | | | 6,000 | Wind and hail | 2 persons injured; loss to crops not estimated; damage to buildings alone, $6,000. | Do. |
| Stephens, Ark. | 4 | | | | 90,000 | do | 1 person injured; loss to crops; property damaged. | Do. |
| Waldo, Ark. | 4 | | | | 70,000 | do | 2 persons injured; loss to crops; buildings damaged. | Do. |
| Cheneyville, La., and vicinity. | 5 | 3 p.m. | 80 | 2 | 8,000 | 2 tornadoes | The first occurred at about 3 p.m., and passed 2 to 3 miles west of Cheneyville over a path 80 yards wide and 1 mile long; the second, of similar size, passed over Cheneyville, total damage, both storms, mostly to buildings, $8,000; several persons injured. | Do. |
| Meadville, Miss., vicinity of. | 5 | 5 p.m. | | 1 | 5,000 | Tornado | 4 persons injured; number of buildings at C.C.C. wrecked; girl found dead under demolished tenant house she occupied; property damaged. | Do. |
| De Roche, Ark. | 6 | | | | 1,500 | Wind | Several buildings unroofed; loss in timber. | Do. |
| Sheridan County, Mont., northern portion. | 8 | 6:30–8 p.m. | 334 | | 50,000 | Gales and intense dust. | Damage estimated to buildings alone; heavy loss of undetermined amount to seeded crops; at least 6 persons injured. | Do. |
| Butte, Mont. | 8 | | | | | High winds and intense dust. | Fences and signboards damaged; extent of actual property loss not estimated. | Do. |
| Watertown, Hubbleton, Waukesha, Oconomowoc, West Allis, Wauwatosa, and Milwaukee, Wis. | 9 | 12:30–1:30 a.m. | | | 2,000,000 | Thundersquall and hail. | Roofs and automobiles damaged; path several miles wide. | Do. |
| Lincoln, ne r, Kans. | 9 | 5 p.m. | 1 2 | | 1,500 | Heavy hail and wind. | Chief damage to gardens; 2,500 panes of glass in 1 greenhouse broken. | Do. |
| Longford and Oak Hill, Kans., and vicinity. | 9 | 7 p.m. | | | 10,000 | Heavy hail | Path 15 miles long; no details. | Do. |
| Cerro, N.Mex. | 10 | 3:30 p.m. | 1 4 | | 2,000 | Heavy hail | Livestock killed. | Do. |
| Cortland, Onondaga, and Madison Counties, N.Y. | 10 | | | | 150,000 | Thundersquall | Man injured; barns and silos demolished; considerable loss to livestock; houses unroofed; hundreds of trees blown down; much damage to telephone and power lines. | Do. |
| Fulton and Saratoga Counties, N.Y. | 10 | | | 1 | | do | Man killed when he accidentaly came in contact with high voltage wire; much property damage. | Do. |
| Jefferson and St. Lawrence Counties, N.Y. | 10 | | | | 25,000 | Electrical | 3 barns and 2 houses burned to the ground with a loss of 44 head of livestock. | Do. |
| Adams, Nebr., 3 miles southwest. | 12 | 4:30 p.m. | 200 | | 2,500 | Tornado | Property damaged. | Do. |
| Cortland and Sherdahl, Kans., and vicinity. | 12 | 5 p.m. | | | 50,000 | High wind | Barns and smaller buildings destroyed; path 15 miles long. | Do. |
| Codell, Kans., 3 miles east. | 12 | 5:30 p.m. | | | 10,000 | Tornado | 2 barns and a number of small buildings destroyed; windmill, telephone and power lines blown down; storm accompanied by hail and excessive rain; dust obscured clouds; path narrow and 3 miles long. | Do. |
| Fairport to Osborne and Downs, Kans. | 12 | 5:30 p.m. | 1 10 | | | Wind and hail | 12 oil derricks near Fairport, and barn and small buildings near Osborne, blown down; heavy hail fell in vicinity of Kill Creek; path 45 miles long. | Do. |
| Dighton, Kans., 6 miles northeast. | 12 | 5–6 p.m. | 1 4 | | 150,000 | Heavy hail | Damage to crops; path 6 miles long. | Do. |
| Ash Grove, near, Kans. | 12 | P.m. | | | 600 | Wind | Damage to brooder houses and small buildings; storm had tornadic characteristics. | Do. |
| Sioux Rapids, Spencer, Ledyard and Rudd, Iowa. | 12 | | | 1 | 4,000 | Tornadic winds, electrical and hail. | Wind destroyed 2 barns and large silo; livestock killed; near Ledyard lightning struck a barn killing a man, horse, and colt; hail accompanied this storm; path of storms several miles wide and from 10 to 15 miles long. | Do. |
| Santuck, S.C. | 16 | 1 a.m. | 125 | | 200 | Tornado | Damage in timber; 4 small outbuildings demolished. | |
| Livingston, Ala., vicinity of. | 16 | | | 2 | 500,000 | Thundersquall | 12 persons injured; property damaged; crop loss. | Do. |
| Lewistown, Mont. | 19 | | | | 1,000 | Hail | Damage to greenhouses; stock killed. | Do. |
| Denmark, Wis., 5 miles west. | 20 | 6 p.m. | | | 2,500 | Wind | 2 barns blown down. | Do. |
| East Troy, near, Wis. | 21 | 3 p.m. | 880 | | 10,000 | Tornadic winds | Several barns and small buildings damaged; fences torn down; farm machinery moved; trees twisted and blown over; path 1½ miles long. | Do. |
| La Motte, Iowa, and vicinity. | 21 | 4:30 - 4:45 p.m. | 1 2 | | 25,000 | Tornadic winds, heavy rain and hail. | Wires blown down; trees uprooted; barns leveled; cattle killed; fruit trees damaged; path 5 miles long. | Do. |
| Fond du Lac County, Wis., western portion. | 21 | 5:30 p.m. | | | 7,000 | Wind | 2 large barns and silos demolished; other buildings considerably damaged. | Do. |
| De Kalb, Mo. | 21 | P.m. | 1 2 | | 25,000 | Hail | Small grains on some farms completely destroyed; great damage to berries; orchards and tobacco beds. | Do. |
| Dayton, Tenn., and vicinity. | 21 | do. | | | | Heavy rain, electrical. | Crops destroyed; 35 bridges washed out; concrete and steel culvert washed 300 feet; many gardens washed out. | Do. |
| Barbour County, Ala., western portion. | 22 | | | 1 | | Electrical | Negro and mule in a field killed by lightning. | Do. |
| Big Cove, Ala. | 22 | | | | | Wind | Dwelling completely demolished. | Do. |
| Fort Valley, Bainbridge, Albany, and Dahlonega, Ga. | 22 | | | 1 | | Hail | Loss to peaches and other crops; several persons cut by glass from broken windows; 10 miles east of Dahlonega, man killed by lightning; estimated damage several thousand dollars. | Do. |
| Orange County, N.Y. | 22 | | | | 3,000 | do | Loss to crops. | Do. |
| Bascom, Fla., southeast of. | 22 | 12–1 p.m. | 1 3 | | 2,000 | Wind and hail | Crops, over an area of 3 square miles, damaged; trees blown down; path 5 miles long. | Do. |

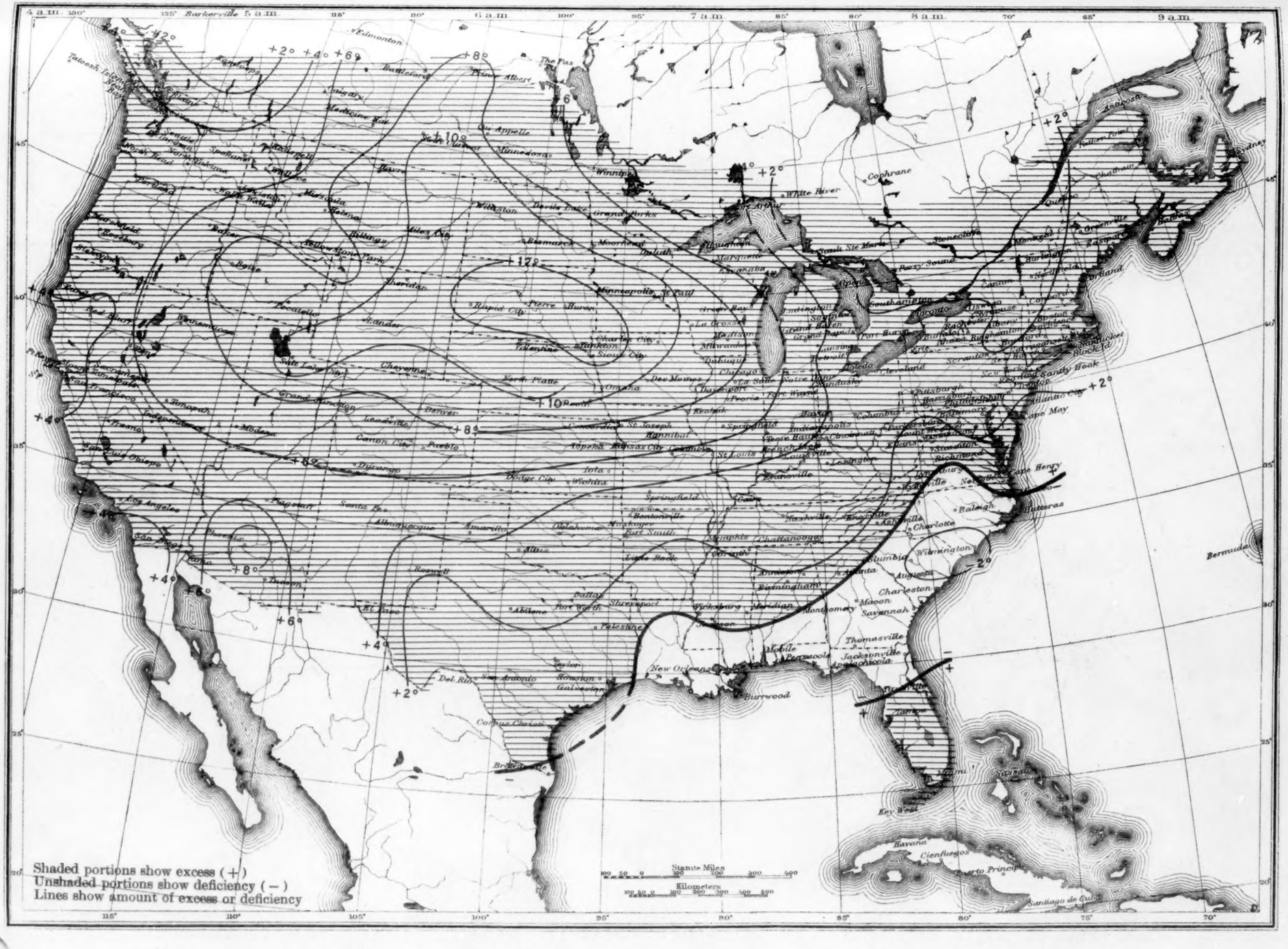
**SEVERE LOCAL STORMS, MAY 1934—Continued**

| Place | Date | Time | Width of path, yards | Loss of life | Value of property destroyed | Character of storm | Remarks | Authority |
|---|---|---|---|---|---|---|---|---|
| Scranton, Pa., and vicinity | 22 | 1:10-4:40 p.m. | | 1 | | Heavy thunderstorm and hail. | Girl, returning from school, killed by lightning at Dupont. | Official, U.S Weather Bureau. |
| Waukesha County, Wis. | 22 | 1:15-8 p.m. | | | | Heavy rain | Thousands of dollars' damage to roads; automobiles stalled; telephone and electric service interrupted; streets and basements flooded in parts of Milwaukee; trees and poles blown down; 3 large hangars moved from their foundations at the Milwaukee county airport; this storm reported to be the heaviest in 25 years. | Do. |
| New York, N.Y. | 22 | 7:30 p.m. | | | | Thundersquall | Several buildings struck by lightning and burned; trolley car struck by lightning and 6 passengers shocked; trees uprooted and poles blown down; storm especially destructive on Staten Island where a club house was struck by lightning and burned; traffic over entire island impeded by heavy rainfall. | Do. |
| Winnsboro, S.C. | 24 | P.m. | | | 5,000 | Hail | Damage to fruits and crops | Do. |
| Orangeburg, S.C., 6 miles west | 24 | | [1] 1 | | 3,000 | do | Severe crop damage; path 3 miles long | Do. |
| Walhalla, S.C., 12 to 14 miles north. | 24 | | | | 3,000 | Heavy hail | Much damage to young crops and to fruit | Do. |
| Jemez and Pueblo, N.Mex. | 26 | 7 p.m. | [1] 2 | | | do | Much damage to fruit and crops | Do. |
| Hollister, Calif. | 27 | 2 p.m. | 660 | | 75,000 | Hail | Loss to crops; path 10 miles long | Do. |
| Orangeburg, S.C. | 28 | 7-12 p.m | | | 5,000 | Wind, heavy hail | Damage to buildings | Do. |
| Charleston, S.C., and vicinity | 28 | P.m. | | | 25,000 | Wind and rain | Yachts and small boats sunk or driven high into the marshes; small damage to wire systems; basements flooded and furnaces badly damaged by salt water; at Holly Beach 5 houses were destroyed; loss to crops. | Do. |
| High Point, Winston Salem, and Greensboro, N.C. | 28 | | | | 5,000 | Wind | Damage to buildings; highest wind velocity ever recorded at Greensboro, 47 miles. | Do. |
| South Carolina, southern portion. | 28-29 | 7 p.m.- 7 a.m. | | | 125,000 | Wind, heavy rain | Damage to truck | Do. |
| Augusta, Ga. | 28-29 | P.m. | | | | Wind and rain | Light and telephone wires and trees blown down; 2 automobiles damaged by falling trees; small brick wall blow down. | Do. |
| Washington State, eastern portion. | 28-29 | | | | | Wind | Strong winds caused loss to apples and cherries | Do. |
| Northern Twin Falls, Idaho. | 29 | 2-3 p.m. | | | | High wind | Electric and telephone poles blown down; trees uprooted. | Do. |
| Otowi, N.Mex. | 30 | 2 p.m. | [1] 4 | | | Heavy hail | Many trees down; crops ruined | Do. |
| Toltec, N.Mex. | 30 | 2 p.m. | [1] 2 | | 4,000 | Heavy hail | Damage to alfalfa and small grains; many turkeys and chickens killed. | Do. |
| Madison County, Fla., northern portion. | 31 | 2:30 p.m. | | | 12,000 | Tornadic wind and hail. | Heavy hail, some stones as large as hens' eggs, damaged crops over a wide area amounting to $10,000; estimated damage to buildings by wind, $2,000; 1 person slightly injured. | Do. |
| Nobles, Jackson, Cottonwood and Redwood Counties, Minn. | 31 | 6:30 - 7:30 p.m. | | | 25,000 | Severe wind | Number of barns, small farm buildings and silos demolished. | Do. |
| Levy, Ark. | 31 | | | | | Heavy hail | Considerable damage to gardens and loss to crops. | Do. |

[1] Miles instead of yards.

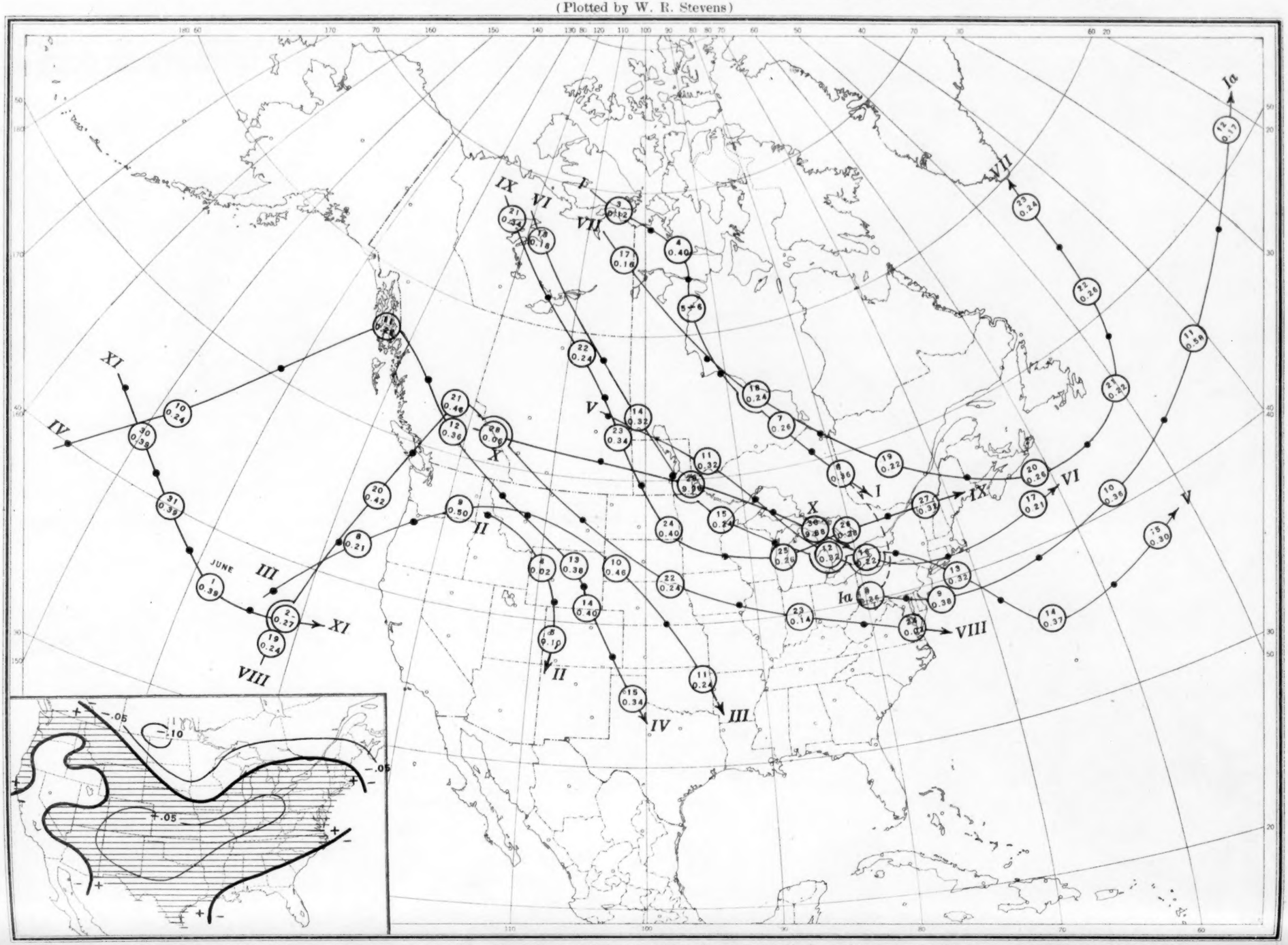
Chart I. Departure (°F.) of the Mean Temperature from the Normal, May 1934

**Chart I. Departure (°F.) of the Mean Temperature from the Normal, May 1934**


Shaded portions show excess (+)
Unshaded portions show deficiency (−)
Lines show amount of excess or deficiency
Statute Miles
Kilometers

## Chart II. Tracks of Centers of Anticyclones, May 1934. (Inset) Departure of Monthly Mean Pressure from Normal

(Plotted by W. R. Stevens)




Circle indicates position of anticyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 8 p. m. (75th meridian time).

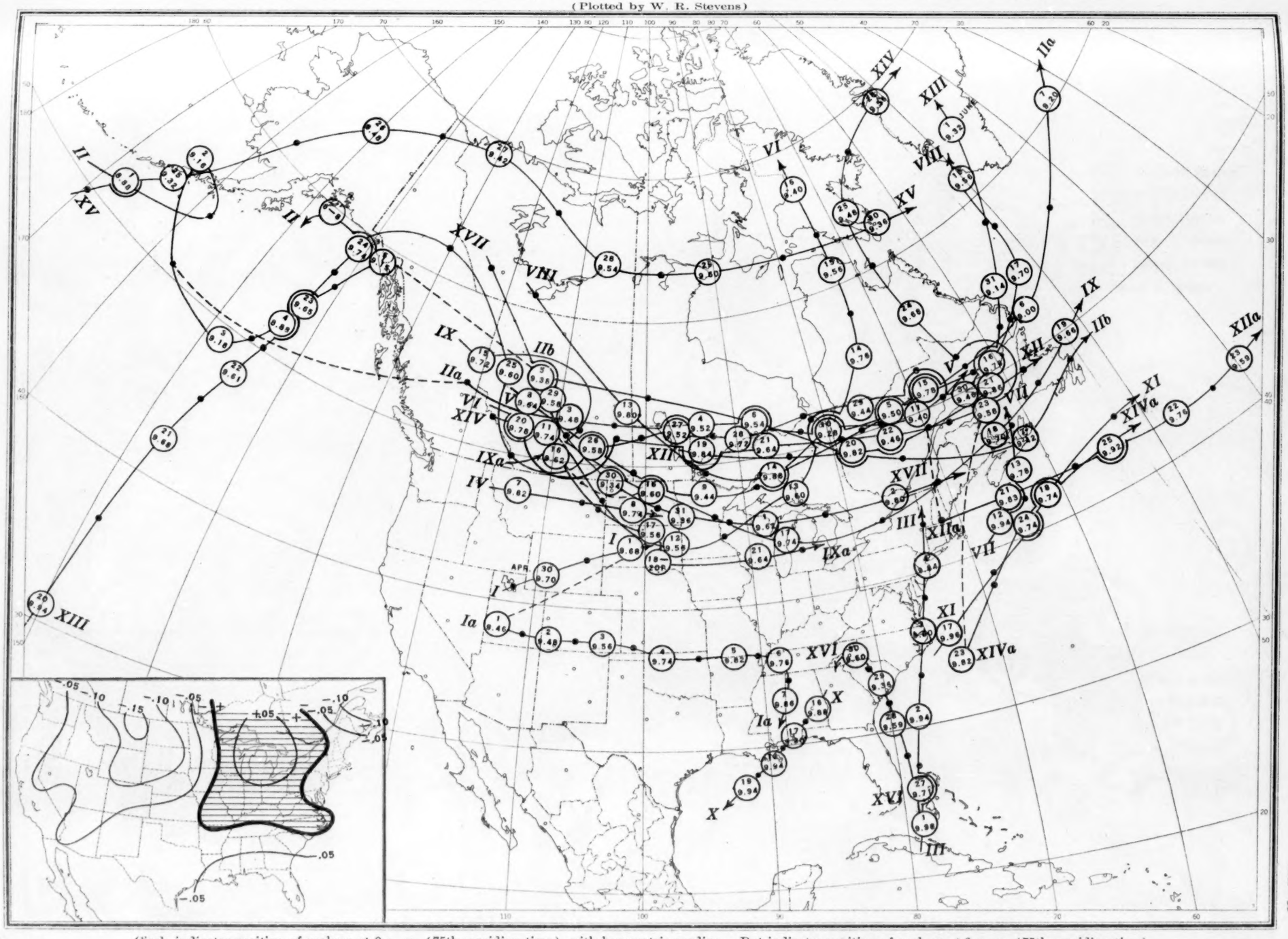
## Chart III. Tracks of Centers of Cyclones, May 1934. (Inset) Change in Mean Pressure from Preceding Month

(Plotted by W. R. Stevens)

Circle indicates position of anticyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 8 p. m. (75th meridian time).

**Chart III. Tracks of Centers of Cyclones, May 1934.** (Inset) **Change in Mean Pressure from Preceding Month**

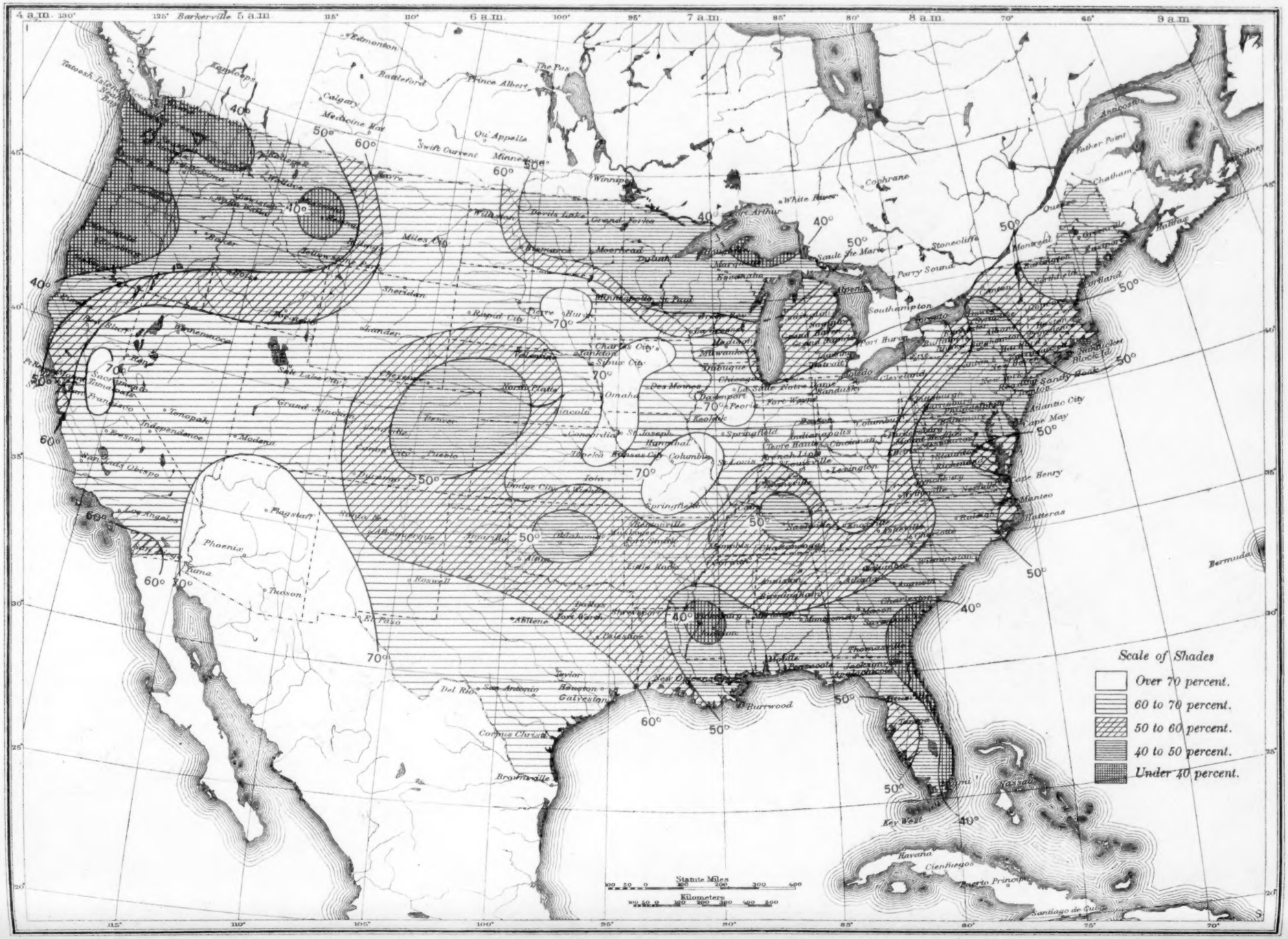
(Plotted by W. R. Stevens)




Circle indicates position of cyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of cyclone at 8 p. m. (75th meridian time).

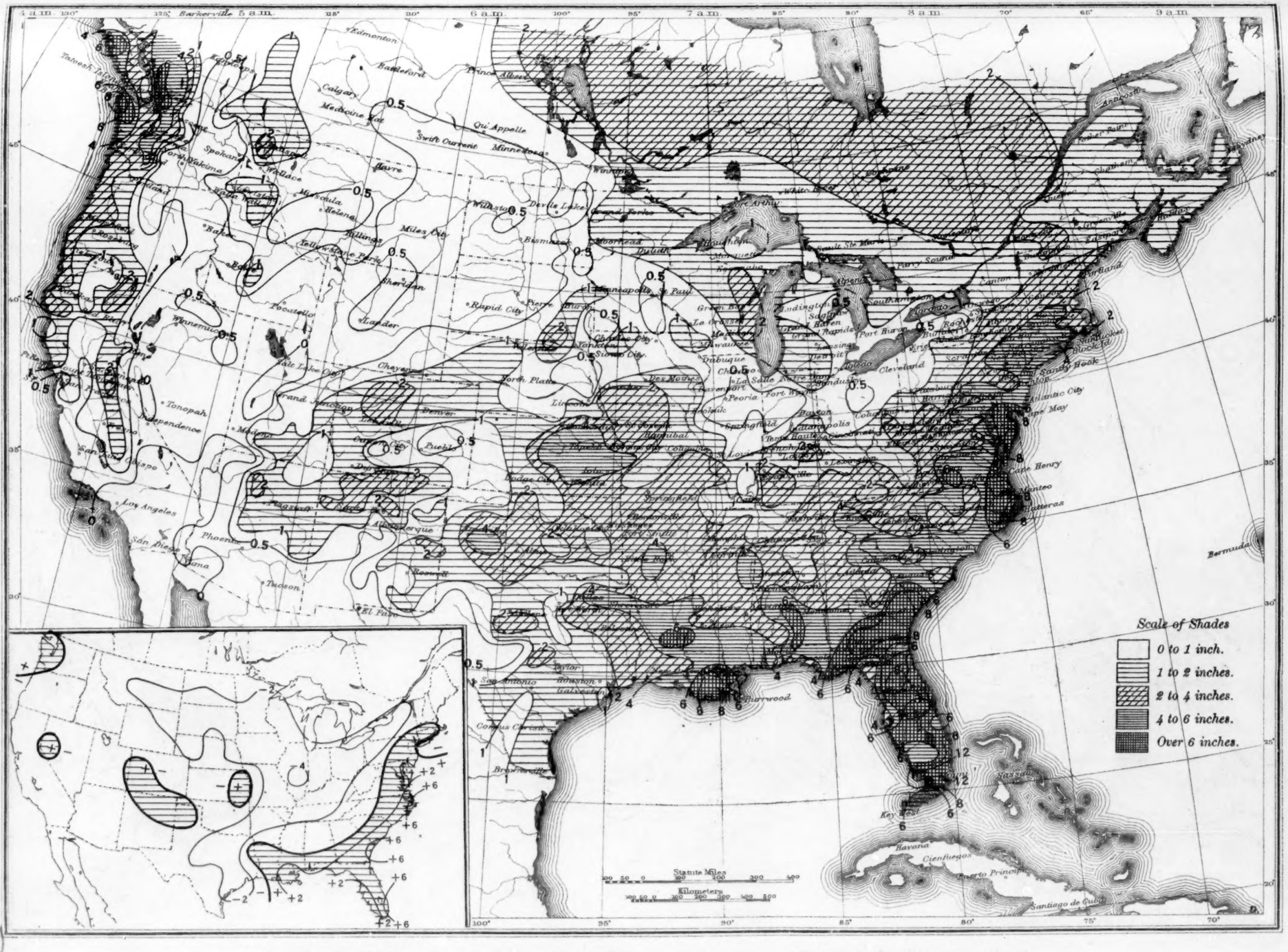
MONTHLY WEATHER REVIEW

## Chart IV. Percentage of Clear Sky between Sunrise and Sunset, May 1934




## Chart V. Total Precipitation, Inches, May 1934. (Inset) Departure of Precipitation from Normal

**Chart V. Total Precipitation, Inches, May 1934. (Inset) Departure of Precipitation from Normal**



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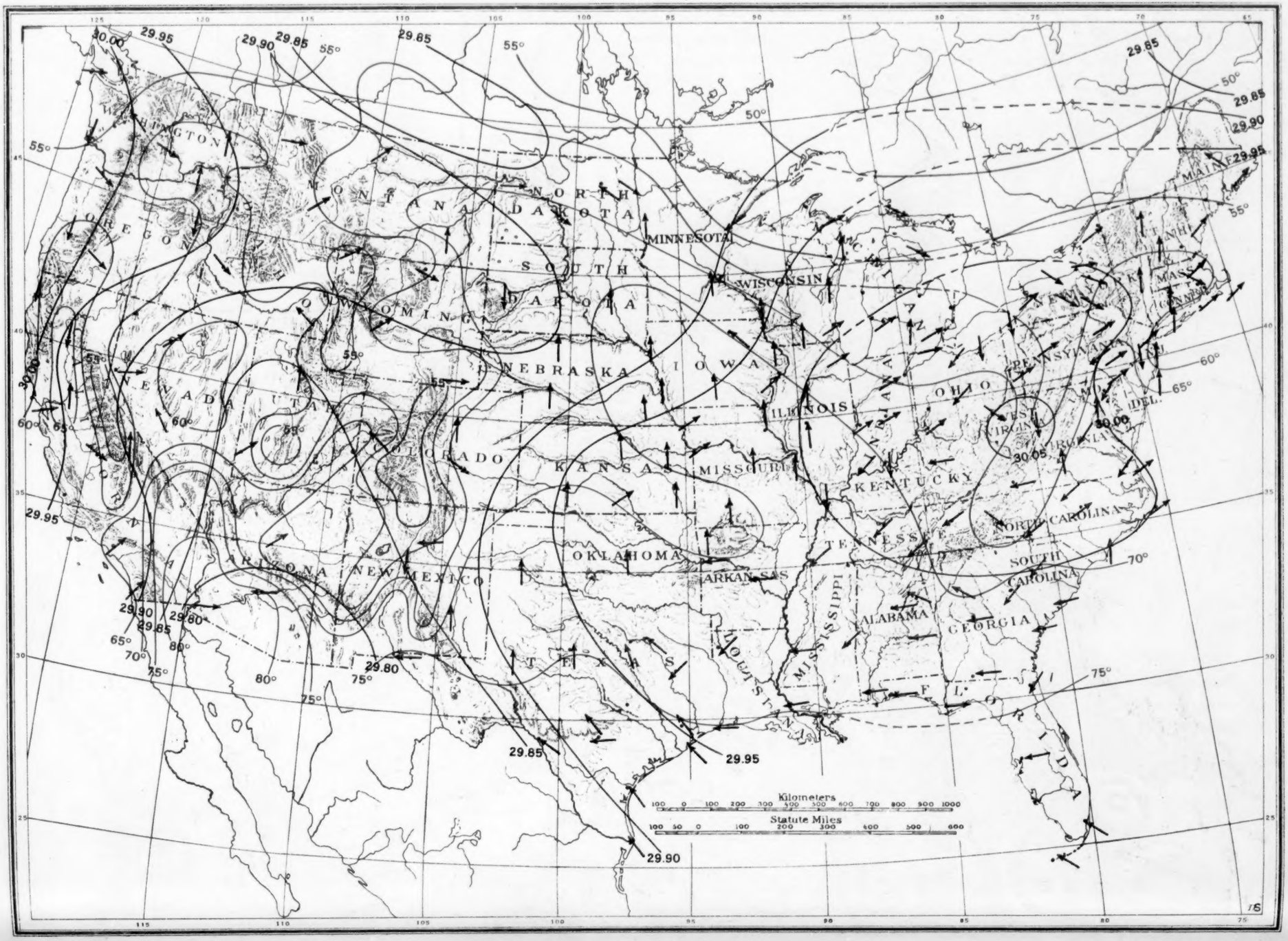
## Chart VI. Isobars at Sea level and Isotherms at Surface; Prevailing Winds, May 1934






## Chart VIII. Weather Map of North Atlantic Ocean, May 14, 1934

(Plotted from the Weather Bureau Northern Hemisphere Chart)

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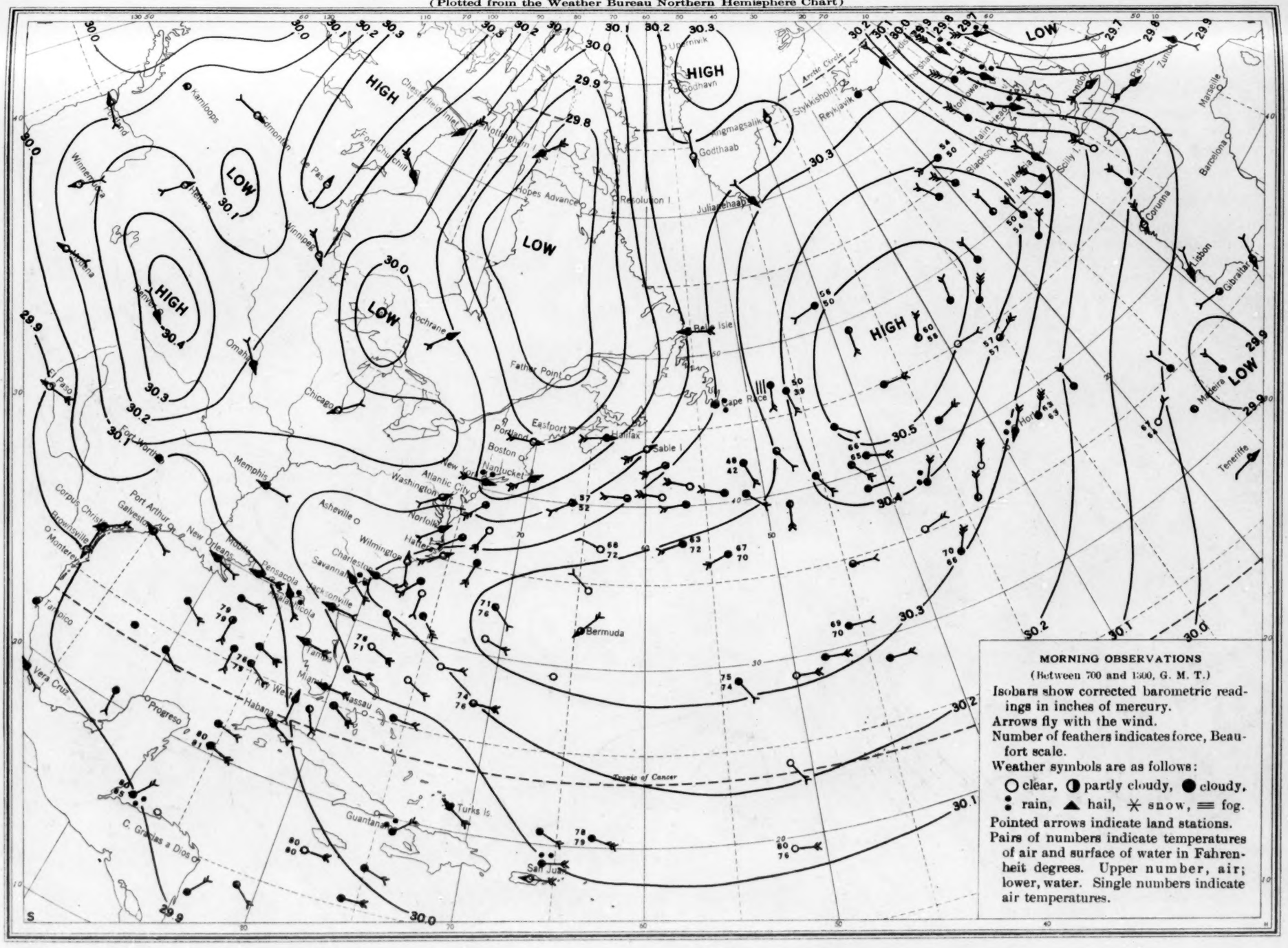
(Plotted from the Weather Bureau Northern Hemisphere Chart)




**MORNING OBSERVATIONS**

(Between 700 and 1300, G. M. T.)

Isobars show corrected barometric readings in inches of mercury.

Arrows fly with the wind.

Number of feathers indicates force, Beaufort scale.

Weather symbols are as follows:

○ clear, ◑ partly cloudy, ● cloudy, ⁝ rain, ▲ hail, ✳ snow, ≡ fog.

Pointed arrows indicate land stations.

Pairs of numbers indicate temperatures of air and surface of water in Fahrenheit degrees. Upper number, air; lower, water. Single numbers indicate air temperatures.



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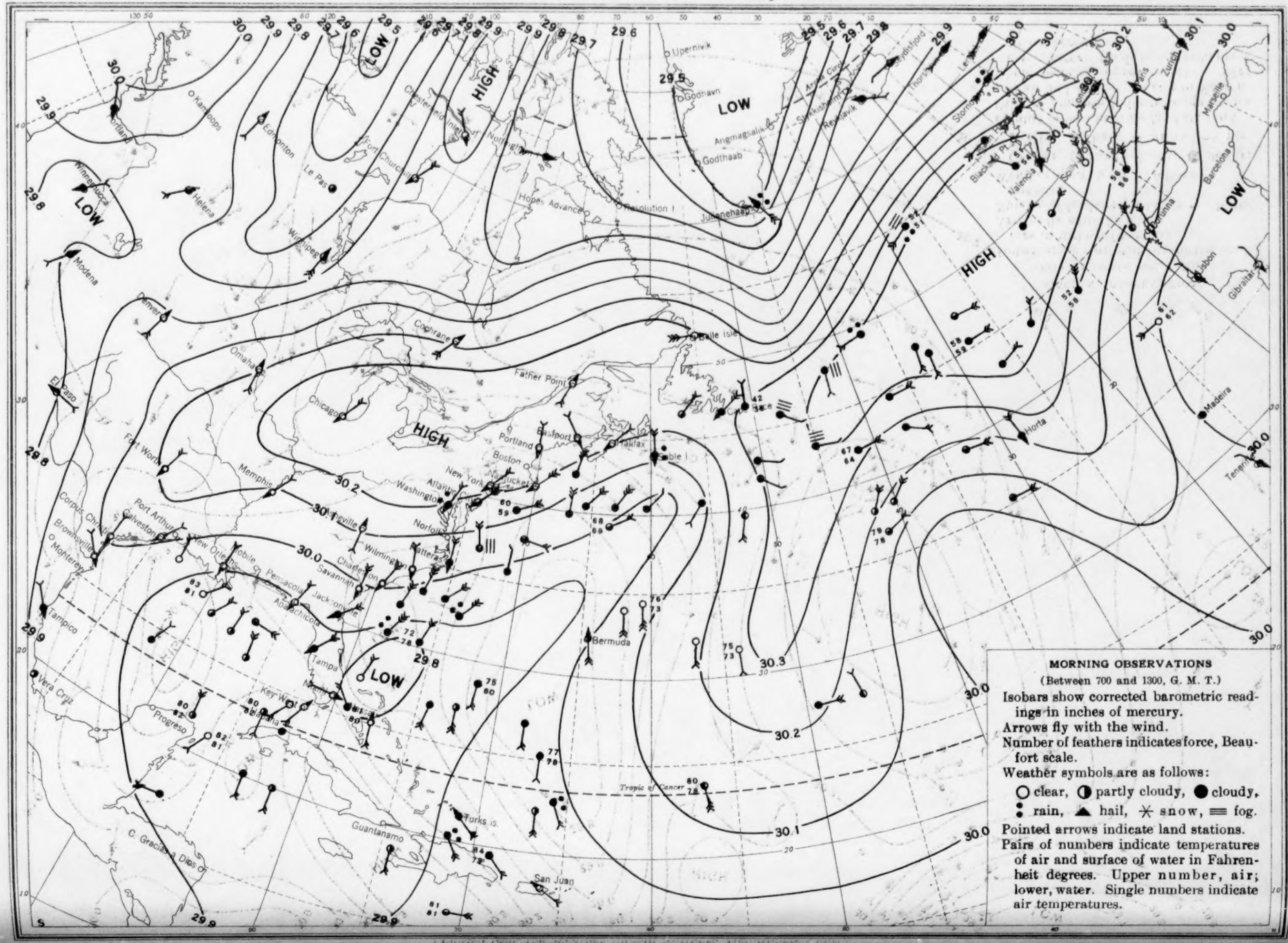
# Chart IX. Weather Map of North Atlantic Ocean, May 27, 1934

(Plotted from the Weather Bureau Northern Hemisphere Chart)

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